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THE

MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

THE

MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

An Illustrated Journal of Practical Microscopy.

EDITED BY

GEORGE E. DAVIS,

F.R.M.S., F.C.S., F.I.C.,

ETC., ETC.

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1883.

PREFACE.

ALMOST before we are aware of it, the year 1883 passes away, and THE MICROSCOPICAL NEWS heralds the fact that the study of the Microscope in connection with Natural History is certainly spreading. We could point within our own circle of acquaintance to at least twenty young people who have essayed to employ the microscope as a means to obtaining a greater insight into Nature's secrets, and we commend these studies to the young as a very healthful and enjoyable recreation.

Not only does the microscope enable us to see the degree of perfection in which many minute things are organized, but it serves to show, when used upon beings in the higher state of life, that every minute part of their anatomy will form objects for study.

Then, again, the microscope serves as a gatherer for many a social evening: evenings furnishing amusement and instruction combined, and it has this advantage, that it only draws the industrious and the enquiring into its vortex.

Our own part in the dissemination of microscopical knowledge has, we fear, been obscure, still we have endeavoured to give our readers the latest information on all those subjects known to be interesting to them. We only wish we could do more, but we fear the expense of enlarging the Journal, or illustrating it in a better manner, will preclude its being done until our circulation is more extended.

We are glad to say that the circulation is on the increase, though

but slowly, and as we are now in our fourth year, it would seem that we had supplied a want. Indeed, as THE MICROSCOPICAL NEWS is the only Monthly Journal devoted to Practical Microscopy, published at a price within the reach of every worker, in however humble a position; it has surprised us that so many working microscopists have not known of its existence. We ask our readers and subscribers to endeavour to disseminate a knowledge of the existence of THE MICROSCOPICAL NEWS, and we thank those most kindly who have been always so assiduous in bringing it before the notice of their friends.

To many contributors we are indebted for the success of the present volume, and to whom we express our thanks for the valuable services so freely given. From our readers we ask indulgence as to our shortcomings, and will be glad to consider any suggestions made with a view to the improvement of the Journal. With this we conclude, and wish one and all

"A HAPPY AND PROSPEROUS NEW YEAR."

VOL. III.

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THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 25. *JANUARY.* 1883.

TO OUR READERS.

THE New Year brings with it its changes, some of them for the better, others for the worse: *The Northern Microscopist* comes in for its share; but while we deprecate making alterations merely for the sake of change, we feel it necessary, in order to keep pace with the times, to depart a little from the course pursued during the last two years.

The first change, if such it can be called, is in bringing prominently forward our subsidiary title THE MICROSCOPICAL NEWS. This our readers will see by an inspection of the headline and cover, but as no substantial change will be made in the mode of selecting matter for publication, except it be to interest a larger number of Microscopists, the Journal may still be regarded as THE NORTHERN MICROSCOPIST. In fact we had for some time been aware that a more general title was needed, but we did not desire to make any change hastily, and, therefore, waited and well weighed over the probable advantages of such a proceeding until quite sure that it would not be inimical in any way to our readers' interests.

We shall also endeavour during the present year to entertain a larger body of Microscopists than heretofore, by selecting a greater number of shorter articles for publication instead of the few longer ones, and we hope also to be able to maintain the character of the Journal for its explanatory illustrations as in the past.

One change will, we have little doubt, be heartily welcomed by all those correspondents who have written us many letters upon the subject during the past twelve months. The Proceedings of Societies will, in future, not appear at such length, but a good abstract made, containing the chief features of the Proceedings, in novelty and interest; some will not need abstracting, as they are already concise, and as a guide we would refer to the proceedings of the Manchester Cryptogamic Society.

We do not wish by these remarks to deter the Secretaries of any

Society sending in a report of the meetings; we shall be glad to find space amongst the Notes and Queries for such communications, but as we are anxious to increase the value of this last department, it has become necessary to curtail the Notices of Meetings.

Amongst the "innocents" our last page must succumb. The Notes and Queries will absorb this also, as in order to increase the space at our disposal we have decided to reply to correspondents through the post, and to abolish the Sale and Exchange Columns. The few exchanges which have come in during the past month have been placed amongst the Notes and Queries, in order that the senders may not be disappointed.

We are glad to state that the sale of the Journal has improved during the past year, and as the present changes are the outcome of the expressed opinions of many correspondents, we trust they will meet with the approval of our readers, and so lead to the continued extension of the circulation.

PLANT CRYSTALS.

DR. ASER POLI.

AFTER Malpighi, who was the first to discover the existence of Plant Crystals, the principal names connected with this subject are Sanis, Holzner, and Gulliver, but the works of the last mentioned, though containing many important observations, are very little known.

These crystals may be roughly divided into two classes, viz.: those which are composed of calcium oxalate, and those which are not; the former class being distinguishable from the latter by their insolubility in water and acetic acid. Crystals of calcium carbonate and sulphate do not occur in plants.

Calcium oxalate crystallizes in two systems—in the tetragonal with three molecules of water, and in the monoclinic with one molecule of water. The octahedrons (as crystals of Begonia, Tradescantia, &c.), are generally tetragonal, while the short prismatic crystals, the raphides, and all those crystals which were formerly believed to be sulphate of calcium (as the long prismatic crystals of Iris) are monoclinic.

Gulliver distinguished four principal forms of plant crystals,—raphides, sphæraphides *(drusen* of the Germans), short prismatic crystals, and long prismatic crystals. Of these the first are frequent in Mono-cotyledons, and occur also in some Dicotyledons. They are found in Vitaceæ, Balsaminaceæ, Galiaceæ, and Onagraceæ, while in the British Exogens their presence is so confined to the last three orders as to form one of their characteristics. *Hydrangea*

differs from the Saxifragaceæ by possessing them, while their absence distinguishes *Montinia* from the Onagraceæ. The other crystals may occur free in the cavities of plant cells, as is the case with many found in Gesneriaceæ, Bigmoneaceæ, Scrophularineæ, and Labiatæ, and, possibly, the *crystalline powder* of *Sambucus*, and many Solanaceæ. It may also happen that one is found in each cell, and this is the more common arrangement, especially with those that are grouped in *druses*, and with the short prismatic crystals of the bast cells. There is an interesting form of crystal which is surrounded by an integument of cellulose fixing it to the wall of the cell. These were first observed by Rosanoff, in *Ricinus* and *Kerria Japonica*, but afterwards by other observers in many more plants. Crystals are also formed in the walls of cells, in the epidermic cells of many species of *Sempervivum* and *Mesembryanthemum*, and in the liber fibres of many Coniferæ.

These plant crystals, by their regular occurrence or non-occurrence, form constant characters of many families and groups of plants. Thus, in the Lemnaceæ the genus *Lemna* contain raphides, while in the genus *Wollfia* they are wanting. In the stem, leaves, and fruit of Vitaceæ every form of crystal is found.

Very little is known of the physiological functions of these bodies. Oxalate of calcium is generally accumulated in those portions of the plant which have ceased to take part in its growth, and as it is often eliminated by the fall of dead leaves and old bark, it seems to be a useless product. It remains where it is formed, and is not dissolved again. It is also worthy of note that in the female flowers of *Ricinus* sphæraphides are plentiful, while in the male flowers they are almost wanting.

J. R. M. S. October, 1882.

THE ORANGE COCCUS.

By J. W. Gooch.

Abstract of paper read before the Windsor and Eton Scientific Society.

THE season for the importation of Oranges into England is now about to commence, and I beg to draw the attention of your readers to the immense pleasure they may experience in studying the various inhabitants of the surface of oranges of different kinds. Besides fungi and acari, the rind of the orange is infested with several species of Coccus: oranges from St. Michaels being the most prolific in microscopic specimens. On their surfaces can be studied the various stages of development of the Coccus, at the same moment, from the egg to the perfect male and female, and thus in the winter's evening, when the whole of our own insect

world appears dormant, can we trace out the life history of these interesting creatures. The inhabitants of the scale are alive, and I have often kept the perfect males for several days in an ordinary live-box.

Fig. 1.

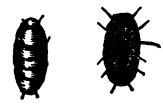

Fig. 2.

Fig. 3.

The Coccus, *Tecamium Hesperidum*, is the most common species, and is found upon oranges and lemons, and also upon the leaves, stems, &c. of our own fruit trees, doing much damage by sucking up the juices of the plants they inhabit.

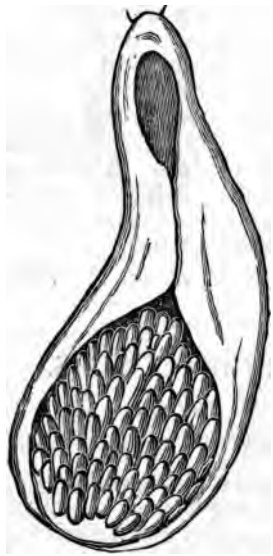

Fig. 4.

Fig. 5.

If we examine an orange infested with Cocci, we shall observe upon it scales of various sizes, large broad ones covering the females, long narrow ones the males, whilst those of intermediate size contain the larvæ and pupæ in different stages of existence. The eggs are tiny oblong bodies, which the female deposits under

the scale, gradually receding towards its apex, and finally drying up. Sometimes there are as many as 300 eggs under one scale, and these, if watched carefully, may be seen to split at one end and the larva to escape. This latter is active and wanders about for a time, finally thrusting its proboscis into the orange, and remaining fixed for life. It soon begins to grow and to secrete "lac" for its protection. The female appears never to lose her proboscis, but the pupa of the male is without it.

Fig. 6.

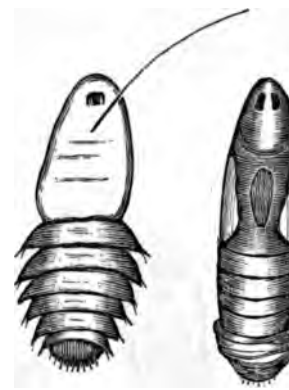

Fig. 7.

Fig. 8.

The various stages of the insect can be well seen with 1 in. objective, and, when mounted, make beautiful microscopic objects. A reference to the diagrams will teach more than a description of the various organs, and to these, therefore, the reader is referred.

1. Eggs, larva escaping from one.
2. Larva, upper and under surfaces.
3. Upper surface of larva, which has grown larger, after having become harder, settled down, and commenced to secrete lac.
4. Female scale, containing eggs.
5. Male scale, containing perfect insect.
6. Perfect female, under surface.
7. Larva of male insect.
8. Pupa of ditto, casting off skin, and losing sucking tube.
9. Ditto, more fully developed.
10. Perfect male insect.

Figs. 1, 2, 3, as seen with 1 in. Ross, with A eye-piece.
Figs. 4 to 10, with 1½ in. ditto.

THE STRUCTURE OF THE CHARACEÆ.

By Charles Bailey, F.L.S.

A Paper read before the Leeuwenhoek Microscopical Club, Manchester, 27th October, 1882.

(Concluded from page 353. Vol. 2.)

VII.—Structure of the Oospore.

We must now turn to the oospore, which is a more simple organ than the antheridium. In its early stage, and prior to fecundation, it takes the shape of a little spiral tower, surmounted by a crown, but when quite ripe it becomes ellipsoidal in Chara and nearly globular in Nitella.

Fig. 9.

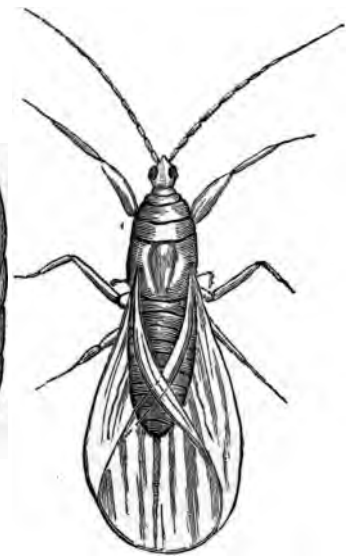

Fig. 10.

It is invested by an envelope composed of five tubular cells, which may be regarded as five leaves cohering by their sides, and arranged spirally round the oospore; the limits of these tubes are clearly marked on the ripe shell by bands or raised lines. In their earliest stage they contain chlorophyll which in the progress of growth becomes changed into a brown or black lignified substance, whose nature has not yet been determined; their surface is mostly

smooth, but in some species it is netted or pitted, and in others, there is a thick granulated layer of carbonate of lime, contained in a soft hyaline membrane.

The five spiral tubes project beyond the summit of the oospore into as many free ends, which, together, constitute what has been termed a stigmatic-crown, from the erroneous supposition that it was analogous to the stigma of a flowering plant. This crown is more pronounced in the Charas than in the Nitellas, and it is persistent; in the Nitellas it disappears early.

These free ends of the spiral tubes also show another distinction between the two principal divisions of the family, viz., that the teeth of the crown in Charas are unicellular, while in Nitellas there is a transverse septum dividing each tooth into a pair of cells. Braun was the first to point out this character, and he considers it the best differential character for separating the two genera.

In the young state of the investing tubes there is a continuity between the prolongation at the free end, and the tube from which it originates; but later on a septum appears and fixes the limit between each tooth and the tube of which it is the prolongation.

As the oospore ripens, the upper ends of the twisted tubes form a space or chamber immediately between the base of the crown and the summit of the oospore within; this chamber is closed below by a diaphragm in which a narrow opening is said to form the communication between the upper chamber and the papilliform summit of the oospore.

The portions of the five tubes which form the walls of this chamber then separate from each other, so as to produce narrow slits or openings, through which the antherozoids make their way to the uppermost of the two cells which compose the inner portion of the oospore.

Good figures, showing the way in which the antherozoids effect an entrance through these slits, are given by Pringsheim in the plate issued with the *Monatsbericht d.k.p. Akademie de Wiss. zu Berlin* for May, 1871. So much for the external parts of the oospore.

Its inner portion consists of an ovoid or globular body containing two cells with tolerably thick walls formed of cellulose; the longer of these two cells is filled with a colourless fat and with grains of starch. The starchy granules were at one time considered to be sporules, but erroneously.

When ripe the oospore drops away from the parent plant and falls to the bottom of the pond ready for germination in the autumn, or after the winter cold.

VIII.—Germination of the Oospore.

The mature oospore contains two cells, a nodal cell and a basal

cell, the former being very much smaller than the other. This small cell is the all-important cell, as all the growths succeeding germination originate from it; its shape is that of a plano-convex lens, the flat side being against the basal cell.

On germination the nodal cell enlarges sufficiently to burst the crown, when it is seen to be divided into two cells by a septum in the direction of the long axis of the oospore; both these cells emerge through the crown as obtuse cylindrical tubes.

These two cells are indistinguishable from each other at first, but one of them very soon exhibits all the characters of the peculiar jointed and branched root: while the other forms the first, or principal, pro-embryo of the future Chara plant.

This second cell takes a much more active development than the other; at first there is a single-celled tube-like growth at the apex of the principal pro-embryonic cell; then it is divided at its upper end by a septum forming an independent cell; this cell by further subdivision is changed into a pro-embryonic apex consisting of from two to six series of cells; further growth in length and breadth of these cells next takes place, when they form the large leaf which rises with the whorl and normal stem-bud of the pro-embryo; this normal stem-bud thus becomes the first stem of the Chara.

The source from which all this growth has been supported is the large basal-cell of the oospore; the nodal-cell is the active organ, the basal-cell is its storehouse. While the growths of the nodal-cell have been progressing the basal-cell has kept within its hard shell, its reserve material gradually giving place to a watery fluid. By the time that the young plant has put forth its first leaf-shoots it has consumed all the food stored up in the basal-cell and all that is left is a shell filled with water.

IX.—The Pro-embryo.

The question now remaining to be determined is, what is the morphological value of the growths springing from the small nodal-cell.

Up to the publication of Pringsheim's paper in 1863 it had been concluded that the true sexual plant sprang directly from the nodal-cell, but Pringsheim's interpretation of the facts here set forth suggested that the first developments of the nodal-cell constitute a comparatively inconspicuous growth, to which he gave the name of "pro-embryo." He further concluded that it was homologous with the "protonema" developed from the spore of a Moss, and as leafless structures intervene between the spore and the leafy plant both in Characeæ and in Muscineæ, he concluded that the two orders belong to the same alliance.

Mr. A. W. Bennett and others, accepting this relationship,

suggest that the Characeæ are mosses which have been rendered abnormal by their aquatic habit, in which the formation of the non-sexual generation (sphorophore) has been altogether suppressed. (See *Journal of Botany*, No. 187, July, 1878, p. 202.) Dr. Vines, who has carefully discussed these relationships (*Journal of Botany*, No. 192, December, 1878, p. 355) would appear to be nearer the truth in regarding the Characeæ as an independent group intermediate between the Carposporeæ and the Muscineæ, thus linking the Thallophytes to the Cormophytes; in the structure of their vegetative and reproductive organs they resemble the cormoid Thallophytes on the one hand and the thalloid Cormophytes on the other.

MOSS DEVELOPMENT.

By W. Stanley.

MOSSES are distinguished by a sharply defined alternation of generations, and are principally developed from true spores, as in the sporangia of ferns.

Spores are described as reproductive cells, resulting from a vegetative process, excited by the act of sexual union, in consequence of which they arise on the second (non-sexual) generation (sporophore) which springs from the fertilized oosphere of the first (sexual) generation (oophore).

Zygospores, Oogonia and Carpogonia, resemble the capsules of Mosses and the sporangia of ferns, and are the result of sexual fertilization, but their Zoospores, Oospores and Carpospores do not always give rise to such distinct alternation of generations, the second or non-sexual generation being a gradually increasing structure, in many cases rudimentary, and in others entirely suppressed.

In the typical Mosses the filamentous thallus, or Protonema, arises as a tubular bulging of the endospore, which lengthens considerably by growth at the apex and becomes divided, the divisions (septa) being oblique; branches are formed immediately behind the septa, and in their turn become divided; the opposite portion of the endospore frequently gives rise to a transparent rootlet (rhizoid) which penetrates into the ground. Fig. 11.

The Protonema is at first colourless, but the cells resting upon the ground soon assume a brown colour, while the upper cells develop abundance of chlorophyll granules, hence it is nourished independently of assimilation, and in some genera the densely matted filaments cover a surface of from one to several square inches in size. It generally disappears after it has produced the

leafy stems as lateral buds, but in the Phascaceæ, Pottia, and Physcomitrium, the protonema remains even after the capsule has been developed, and all the stages of development are present simultaneously.

The formation of the protonema, as well as the structure of the capsule, differs from the typical Mosses in the Sphagnaceæ, *S. acutifolium*, Fig. 12; Andreæaceæ, and Tetraphideæ, *T. pellucida*, Fig. 13, and consists, when growing upon a firm substratum, of a flatly expanded plate of tissue. In Andreæa, according to Kühn, the contents of the spore divide, while still within the closed exospore, into four or more cells, and a tissue is thus formed similar to that produced in the spores of some Hepaticeæ, as Radula and Frullania.

The Moss stems are developed from buds, which arise as lateral branches upon the protonemal filaments, and never at the end of them.

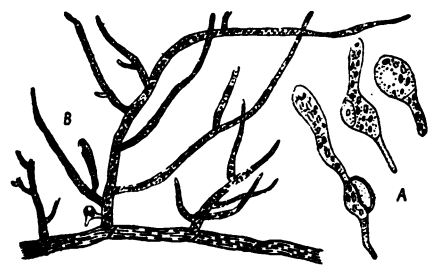

Fig. 11.

From observations made by Shuck and Müller, the principal filaments of the protonema and the larger rhizoids are considered by Sachs to be very rudimentary, much-elongated Moss stems, as the oblique septa formed in the elongated apical cells are regularly inclined spirally in three or more directions; just in the same manner as the principal walls of the segments of the trilateral apical wall of the Moss stem. These walls do not, however, intersect, as in the stem, since the segments are so long.

Each segment is capable of forming a protuberance immediately behind the front wall, which becomes shut off by the foliar wall, and after elongation is again divided into two cells by a basal wall as in the segments of the stem; the upper of these cells corresponds to the mother cell of the leaf, while the above developes a lateral branch as in the case of the Moss-stem. Fig. 11.

The position of the walls of these cells is precisely similar to that of the corresponding walls of the stem, the protonema differing from the stem simply in the distance of one segment from the other, so that a Moss-stem is a protonemal filament with more

rapidly-developed and consequently very short segments, forming mother-cells of leaves which at once grow out into expanded leaves instead of into filamentous structures.

The apical cell of the stem is two-sided in Schistostega and Fissidens, in the rest of the Mosses it is a three-sided pyramid, with the basal surface turned upwards.

Each segment of the apical cell arches outward and upwards, is cut off by a foliar wall, and developes by further divisions into a leaf, while the lower inner part of the segment produces part of the inner tissue of the stem.

Since each segment forms a leaf, the spiral arrangement of the leaves, or Phyllotaxis, is determined by the position of the consecutive segments.

In Fissidens two straight rows of alternate leaves are thus formed; in Fontinalis three straight rows with the divergence $\frac{1}{3}$, the segments themselves lying in three straight rows, because each newly formed primary wall is parallel to the last but three.

In Polytrichum, Sphagnum, Andreæa, &c., on the other hand, each new primary wall encroaches on the ascending side with regard to the leaf spiral; the primary walls of each segment are therefore not parallel, and the segments themselves, when first formed, do not lie in three straight rows, but in three parallel spiral lines, winding round the axis of the stem, one above another.

The angle of divergence of the consecutive segments, and their leaves, being greater than $\frac{1}{3}$; the phyllotaxis is $\frac{2}{5}$, $\frac{3}{8}$, and so on; the apical cell giving the impression of rotation slowly on its axis while producing leaf-forming segments.

The primary tissue (meristem) situated beneath the growing point of the stem is homogeneous and composed of cells with thin and smooth walls; all the cells are capable of division, and are rich in protoplasm, containing no coarse granules. This tissue owes its origin, though not without exception, to the single mother-cell at the apex termed the apical cell.

In passing over into permanent tissue, it becomes differentiated into an outer and an inner mass of tissue, not generally sharply defined. The cell walls of the outer are usually thickened, and of a bright red or yellowish colour; while the inner cells have broader cavities and thinner walls, slightly or not at all coloured.

In many species of Grimmia, Funaria, Mnium, and Bryum, a central bundle of very thin-walled and very narrow cells is formed in addition to the outer and inner tissue; and in Polytrichum and Atrichum decided thickenings of the cell-walls take place in the central bundles in such a manner that each of several groups becomes surrounded by a thick wall, and they together form a bundle; doubtless these may be held to be fibro-vascular bundles of the simplest kind.

The leaf originates from the swelling of a segment of the apical cell of the stem which is cut off by a wall. The lower part is concerned in the formation of the outer layers of tissue of the stem, and the apical part becomes the apical cell of the leaf. The formation of segments, which is limited, is in two rows to the right and left, and the tissue thus formed advances downwards, ceasing finally at the base.

The whole of the tissue of the leaf in Fontinalis is a single layer of cells, but very commonly a vein, consisting of several layers of cells, is formed from the base of the apex.

Fig. 12.

Often various forms of tissue become differentiated in the vein similar to the central bundles of the stem, and it is stated by Lorentz that the seta of the capsule is always provided with a similar central bundle.

The shape of the leaves of Mosses varies from almost circular through broadly lanceolate forms to the acicular, and are always sessile and broad at their insertion, usually densely crowded, only on the stolons of some species, the base of leafy shoots, and the pedicels of Aulacomnium and Tetraphis, do they remain small and remote.

Round the reproductive organs they usually form dense rosettes or buds, and are termed the perichætial leaves, not unfrequently assuming special forms and colours.

The tissue of the leaf is usually homogeneous, and composed of cells containing chlorophyll, which sometimes project above the surface as mamillæ. In the Sphagnaceæ and Leucobryum the tissue is differentiated into cells containing air, and others which contain sap and chlorophyll, arranged in a definite manner. The cells of the Sphagnaceæ also contain special fibres, similar to the elators of the Hepaticæ.

The mode of branching of the stems of Moss is apparently never forked (dichotomous), but also probably never axillary, although connected with the leaves, and the number of lateral branches is

always much smaller than that of the leaves; they are in many cases definitely limited in their growth, and lead to the formation of ramified systems, similar to pinnate leaves, as in Thuidium and Hylocomium.

The origin of the lateral shoots has been carefully investigated by Leitgeb in the case of Fontinalis and Sphagnum, and the results obtained are of general application to the whole class, since these two genera belong to very different sections.

They agree in the fact that the apical cell, or mother-cell, of a branch originates beneath a leaf from the same segment as the leaf. In Fontinalis the branch arises beneath the median line of the leaf; but in Sphagnum, in consequence of the further development of the mother shoot, the lateral shoot appears at a later period to stand by the margin of an older leaf; articulated hairs arise in the axils of the leaves of Fontinalis and Sphagnum.

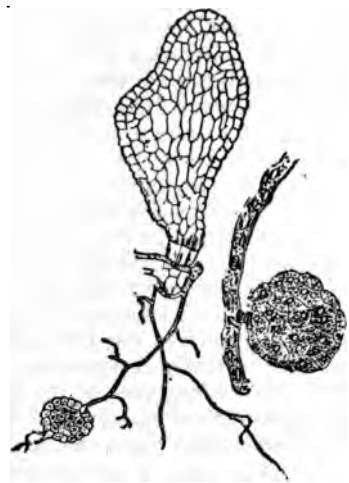

Fig. 13.

The dimensions attained by the leaf bearing axes of Mosses show a wide range, the simple stem in Phascaceæ, Buxbaumia, and others, scarcely reaching one-twentieth of an inch in height, while the largest species of Hypnum and Polytrichum range from 6 to 12 inches, and more.

The thickness of the stem is less variable, being $\frac{1}{250}$ inch in the smallest, and hardly exceeding $\frac{1}{25}$ inch in the thickest forms.

Its dense tissue is, however very firm, often stiff, very elastic, and capable of offering long resistance to decay.

The Root-hairs (Rhizoids) play an extremely important part in

the economy in Mosses, occurring in most forms in large numbers at the base of the stem, and often clothing it completely with a dense reddish brown felt.

They are only distinguished from the protonema by the absence of chlorophyll, and by their tendency to grow downwards, and like it they are capable of forming new leafy stems.

They arise as tubular protuberances from the superficial cells of the stem, elongate by apical growth, and are segmented by oblique septa, and are capable of developing single branches as a protonema growing upwards and containing chlorophyll.

The cells contain a considerable quantity of protoplasm and drops of oil.

Many Mosses are met with which do not produce fruit or spores, yet the continuation of their existence is singularly cared for; the vegetative reproduction of Mosses being more copious and varied than is the case in any other section of the vegetable kingdom.

In the production of a new leaf-bearing stem the peculiarity is presented that it is always preceded by the formation of a protonema; the only exceptions being the few cases in which leaf-buds become detached and commence immediately to grow.

The most important point to be noticed is that both the protonema which proceeds from the spore, and the leafy stems which spring from it, are capable of reproduction of different kinds, and the original protonema may produce upon its branches a smaller or larger number of leafy stems in succession or simultaneously. Sometimes the individual cells become sphericial in form and separate, acquiring thicker walls, and remaining for a time inactive, as in *Funaria hygrometrica*, forming at a later period protonemal filaments.

Next in importance to spores in the scale of reproduction may be placed Gemmæ, stalked fusiform, lenticular or cellular bodies, occurring in *Aulacomnium androgynum*, at the summit of a leafless elongation of the leafy stem (Pseudopodium) in *Tetraphis pellucida*, they are enveloped by an elegant cup composed of several leaves, out of which they fall (Fig. 13). A gemma giving rise to a flat protonema B.

In *Ulota phyllantha*, reproductive cells similar to gemmæ occur at the apex of the leaves (Fig. 14) and they also occur in *Grimmia trichophylla*.

Some species of Phascum and Pottia persist perennially by means of their root-hairs; the plants disappearing completely from the surface of the ground from the time that the spores become ripe till the next autumn, when the root-hairs again produce a new protonema, and upon this new stems arise.

According to Schimper, similar outgrowths occur also in the felted protonema of *Polytrichum nanum* and *Polytrichum aloides*, and on that of *Schistostega osmundacea*.

When the buds arise on underground ramifications of the root-hairs, they remain in a dormant state as small microscopic tuberous bodies (bulbils) filled with reserve food material, until they chance to reach the surface of the ground, when they undergo further development. Fig. 13. (e.g. *Barbula muralis*, *Grimmia pulvinata*, *Funaria hygrometrica*, *Trichostamum rigidum*, *Atrichum.*)

Aerial root-hairs may not only produce a protonema containing chlorophyll, but also leaf-buds without its intervention; and Schimper mentions the remarkable fact that in *Dicranum undulatum*, annual male plants are formed in this manner on the tufts of perennial female plants and fertilize the latter.

The establishment of new colonies of Mosses is also secured by prothallium produced from the basal cells of the deciduous leaves of *Funaria hygrometrica*, *Orthotricum Lyelli*, and *O. abtusifolium*; while the falling branches of Campylopus and Leucobryum also serve for the production of new plants.

(To be continued.)

DR. CARPENTER IN AMERICA.

OUR veteran microscopist, Dr. Carpenter, was present at the meeting of the American Association for the advancement of Science held in August last at Montreal. While there he gave an interesting address to the large audience assembled, upon the subject of the best objectives for biological work.

This address, which sets out so plainly what objectives should be used, has been printed and circulated in the North by a Member of the Manchester Microscopical Society, and, therefore, it would be superfluous for us to reproduce it. Suffice it to say that the address may be found on page 161 of the September number of the American Monthly Microscopical Journal.

The reprint, before mentioned, has been divided into numbered paragraphs, and some of the sentences underlined in red, in order, we suppose, to facilitate discussion, but we would imagine that the propositions advanced by Dr. Carpenter have been so well established by practice as to admit of no useful discussion. There are a few statements, however, not materially affecting actual work with the microscope, that require comment; in every other sense we agree with the spirit of the Doctor's remarks.

We suppose it to be inferred from the statement "that American microscopists are now going over the track that the English passed

over twenty or twenty-five years ago and found no results to biological work," that the English worked with similar wide apertures twenty-five years ago; we would like to know who made these lenses; and if any of them have been measured by the apertometer. We shall be glad to give publicity to any replies to these queries.

Dr. Carpenter very rightly called attention to the subject of penetration: some American and French publications have stated that any amount of penetration in a lens is a fault; but Professor Abbé has shown us that, in every lens, this attribute is a measurable quantity, and an objective is certainly faulty if it does not yield this quantity. He has, moreover, shown us that there is four times as much penetration in a one inch 40° as in a quarter of an inch of 40°, and this should influence us in our manipulations.

One of the absurdities which Dr. Carpenter has endeavoured to spirit away is, that a low power lens of wide aperture, say a $\frac{4}{10}$ths of 150° may be made to do everything. We have pointed out—we hope clearly—in our "Plea for wide Apertures," that an excess of aperture is often given to lenses, with a sacrifice of working distance and consequent penetration, qualities not to be overlooked in the selection of objectives.

We have already mentioned (Northern Microscopist, II., 235) the case of an inch objective of an angle too wide in our opinion, and a still wider aperture has been declaimed against (and very properly too) in the following words by Dr. Carpenter:—"I hear of Americans making one-inch objectives up to great angles for which the Society screw is too small. This makes a very bad ¼ and spoils it for a one inch." With certain lenses we cannot endorse the opinion that it makes a very bad quarter; but we do say it spoils the objective for use as a one-inch lens. In fact the first portion of the proposition is easily refuted by Dr. Carpenter's remarks upon objectives in his work on the Microscope. On page 200 (Sixth edition) he says:—"A good $\frac{4}{10}$ths should resolve the larger scales of the Podura without difficulty, and a good quarter or fifth should bring out the markings on the smaller scales."

Now, according to the Journal of the Royal Microscopical Society, working with the A eyepiece, the $\frac{4}{10}$ths amplifies 125 diameters, the quarter 200, and the fifth 250 diameters, and practical microscopists will admit that these magnifications are none too much to enable the various markings to be seen with any degree of comfort. In his American address Dr. Carpenter is reported to have said, "*A good two-inch should resolve the Podura scale, with a sufficient magnification from the eyepiece*"; that is to say, the eyepieces must magnify up to 125 diameters for the large scales and to 200 for the smaller, or, using the two-inch objective the Journal of the R. M. S. tells us, we must use Ross' E and F eyepieces.

Clearly the two-inch objective, to be a good one, must stand the E eyepiece at least, for, we imagine, "resolving" means resolving *satisfactorily* with the production of a good image in every respect. Now the one inch produces the amplification of a quarter, when used with a D eyepiece, and yet we are told that the inch with D eyepiece makes a bad quarter, while the two inch should stand the B or even higher ocular. We fail to see the logic of the situation, and on the other hand will be willing to travel a few miles to see the Podura scale satisfactorily resolved with a *low angle* two-inch, with whatever eyepiece the manipulator may choose to employ.

Furthermore, in the quotation italicised, we find foreshadowed what aperture Dr. Carpenter would have given to a two-inch objective; for this purpose we photographed the largest scale upon our test slide and counted the markings. The scale measured $\frac{1}{500}$th of an inch in breadth, and possessed 40 rows of markings across it, so that these lines were really $\frac{1}{20000}$ of an inch apart; another scale was measured $\frac{1}{600}$th of an inch, and had 35 rows of markings, or containing lines $\frac{1}{21000}$ of an inch apart;—what does *theory* say should be the aperture which will resolve these lines? Answer: ·207 N.A., or 24° in air. *This is the theoretical minimum angle the two-inch must have to resolve this scale, and the excess above this, actually necessary, depends upon the perfection of the corrections.*

This brings us to another point. The excess of aperture necessary to do the *theoretical* work of the lower angle, depends upon the excellence of the corrections. Now it is well known that the cheap English glasses of low angle are without exception not so carefully finished as the more expensive lenses; they are fair working glasses, no doubt, and not to be discouraged for amateurs' use; we must, therefore, take exception to the paragraph which pits the widest angle American $\frac{4}{10}$ against our cheap ones. Dr. Carpenter tells us that for £10 or £12 a good set of English objectives up to a $\frac{1}{12}$th of an inch may be obtained. What is the experience of our readers? Crouch's list up to the $\frac{1}{12}$th dry adds up to £29 4s. od.; Swift's list to the $\frac{1}{10}$th adds up to £32 14s. od.; and most others in like proportion for their first series. It is true that these opticians, and others like Mr. Collins, produce a second series which adds up to £12 15s. 6d., or even a third series, like Mr. Wray, which up to the one-sixth adds up to £10 18s. od.; but they have these lenses in America also: Collins' half-inch of 45° is £2 5s. od.; the Bausch and Lomb half inch of 42° is £1 16s. od.; Collins' half-inch of 40° being £1 5s. od.

Tolles $\frac{4}{10}$ths of 140° costs £13; and we venture to say it would cost quite as much if made in this country. The Bausch and Lomb $\frac{4}{10}$ of 55° costs £2 5s. od.; while Powell and Lealands of 80° $\frac{4}{10}$ths costs £5 5s. od., their half-inch of 40° £4 4s. od., and the $\frac{1}{12}$th £12 12s. od.

If now we select a 4″, a 2″, 1″, ″1/2, ″1/4, ″1/8, and ″1/12 from two catalogues, one Messrs. Powell and Lealands', the other from a catalogue having a third series, we shall find their prices as follow:

Fourth	...	9°	...	£1	10	0	...	9°	...	£1 0 0
Two-inch	...	14°	...	2	15	0	...	12°	...	0 17 0
One-inch	...	30°	...	3	3	0	...	16°	...	0 17 0
Half-inch	...	40°	...	4	4	0	...	40°	...	1 10 0
Quarter	...	95°	...	5	5	0	...	70°	...	1 5 0
One-eighth		100°	...	7	7	0	...	110°	...	2 10 0
One-twelfth		145°	...	12	12	0	...	160°	...	4 17 6
				£36	16	0				£12 16 6

So it will be seen that while "a *good set*" of English objectives may be had for £10 to £12, yet a *set of good* English objectives costs over £36. We should like to see these *two series exhibited side by side*, when in the words of the A. M. M. J., so neatly reproduced by the member of the Manchester Microscopical Society, there is no doubt that "the difference between them" would be "so striking as to attract universal attention." If any one still believes in the excellence of a cheap 2″ of 12°, let them exercise their ingenuity on the Podura scale until they have resolved it.

A few more words and we must conclude. Dr. Carpenter has advanced such a powerful argument in support of the aperture shutter that we cannot overlook it. He stated having made a trial of two half-inch objectives of 90° for the study of Polycistina, the perspective was exaggerated and so he cut the aperture down with a stop to 60°, and finally to 40°, "when the perspective was true." The results of this cutting down of the aperture were so encouraging that he ordered one specially to be made for him of 40°, and no doubt this was necessitated by the exceedingly short working distance of a half-inch of 90°, already pointed out by the Editor on page 104 of "Practical Microscopy." Why not have used the aperture shutter, or, as we would have preferred, have used a one-inch of 40°, when the observer would have had double the amount of penetration that he had with the half-inch.

PREPARING DRAWINGS FOR THE MICROSCOPICAL NEWS.

THERE is no doubt that the introduction of engravings into the text of Microscopical literature increases the value to the reader in a very great degree. Many papers cannot be well understood without diagrams, especially by those who are still unacquainted with the rudiments of the subject, and many such communications must necessarily be passed over by microscopists as not being sufficiently lucid to be studied without the expenditure of considerable trouble and expense.

We have always endeavoured to illustrate the papers contributed to *The Northern Microscopist* as satisfactorily as our income would allow; and so certain are we that the course is a correct one, that we have been much exercised to find a method whereby the process of illustration might be considerably extended. We have, in our two former volumes, attempted several methods of preparing the illustrations. Photography, as in No. 21, 1882; Photo-lithography, No. 3, 1881; Woodbury-type, No. 4, 1881; Chromo-lithography, No. 11, 1881; Ordinary lithography, as exemplified in the six plates accompanying Mr. Dallinger's paper on "Life Histories and their Lessons" in last year's volume, while the remainder consist of wood blocks or metal plates produced by a process to which we wish to draw the attention of our readers. The wood blocks have in great part been prepared by photography, either from the objects themselves or from large class diagrams. For instance, the blocks illustrating Mr. Rideout's paper on *Dytiscus marginalis* were photographed from slides sent to us by the reader of the paper, and cut on wood by a London engraver. The illustrations inserted in Mr. Blackburn's paper on the Ephemeridæ were reduced from the large diagrams exhibited to the meeting at which his paper was read, by means of photography, and transferred to wood for the engravers.

All these processes are necessarily expensive, and none of them could furnish illustrations at a sufficiently cheap rate to enable us to give more than one illustration monthly, if of any degree of complexity. We have, therefore, great pleasure in calling attention to Mr. Stanley's articles on Mosses, in which the illustrations have been prepared at so low a cost as to enable us to successfully illustrate his chapters.

The process by which the blocks have been prepared, viz.:— Photo-zincography being one, but little known, a few experiments had to be made in order to ascertain what style of original drawing produces the best illustration. The development of the ideas may be seen by first inspecting Figs. 15, 16 and 17 in the September number of our last year's volume. The illustrations there represented

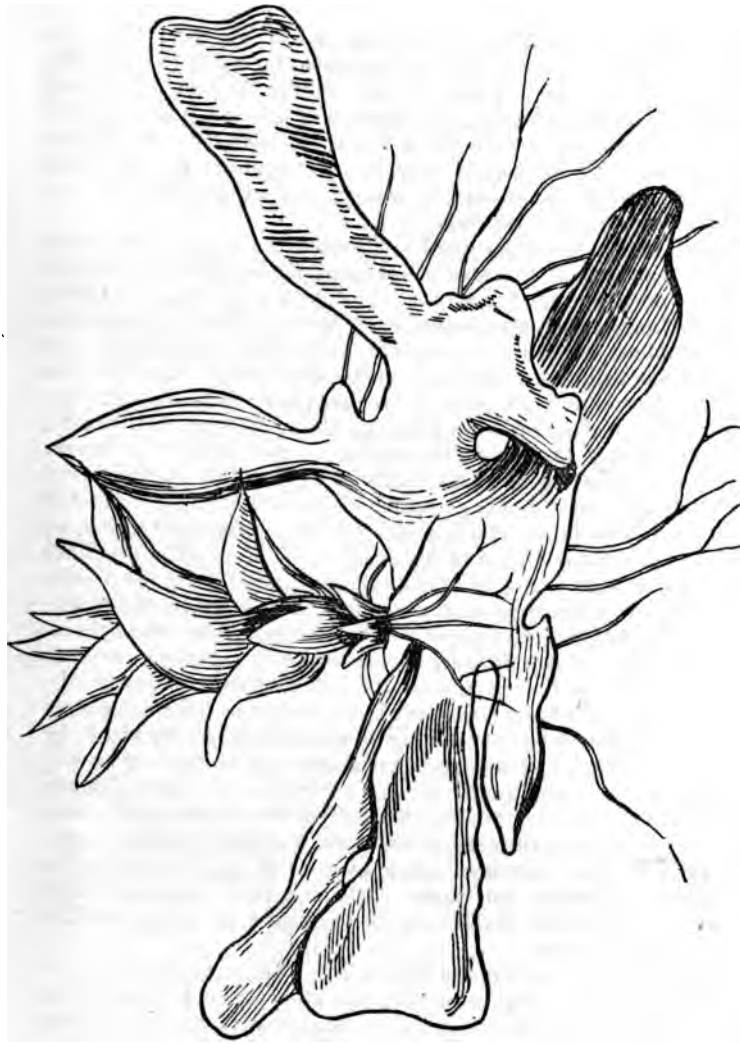

Fig. 14.

were reproduced of the same size that they were drawn, with a result not very pleasing to the eye of a critic.

The next blocks were more successful, and may be found as Figs. 18, 19, 20 and 21 on page 268, Vol. II.; they were over-reduced, but still the reader will have some difficulty in distinguishing them from ordinary wood-cuts. The plate in the November number is a *facsimile* of a careful drawing by Mr. Stanley, while the papers upon the "Human Eye" in the same number has 10 illustrations produced by the same process.

The value of Photo-zincography for illustrating Microscopical literature having been established, it behoves us to show our readers how the matter should be accomplished.

The drawing should be made upon cream laid paper with an ordinary pen, and of a size three diameters as large as is finally required in the block. Those upon page 344, 1882, were drawn, so that a line reaching from the outside edges of the capsule of *H. sericeum* and the leaf of *H. lucens* measured exactly 11 inches, and the result is perfectly satisfactory.

The blocks in the present number, illustrating the article on "Moss Development," have been reduced to one-third their original size, and to show the reader exactly how the original should be drawn, we have reproduced Mr. Stanley's drawing of Fig. 12, and which will be found on page 20 as Fig. 14.

Our readers may now see how they can aid us, and how we may be able to aid them. We shall be happy to illustrate any paper we deem of sufficient interest to the majority of our readers if drawings are sent to us, prepared as herein described.

MOUNTING THE PROBOSCIS OF A FLY. PREPARATION.

By T. W. Lofthouse.

KILL the fly by putting it into a bottle containing a little carbolic acid that has been rendered fluid by the addition of a drop or two of water,—no more water should be used than is necessary. Acid, so prepared, may be obtained from Mr. Ward. Cut off the head, and place it in a small porcelain saucer and cover with a little of the acid, which must be changed about every other day for say a week, or until it ceases to become coloured. The tongue will then, in most cases, be found to be protruded, or may be forced out by slightly pressing the head.

Expanding.—To expand the tongue, it should be placed in the centre of a glass slip, and put upon a piece of wood, about 5 inches

long by 1¼ inch wide, into one end of which a piece of wire has been inserted and bent over to form a clip, the centre being covered with a circle of *white* paper to form a light background. A piece of glass about 1 inch by 1½ inches, to be used as a presser, is placed upon the glass and under the spring, and is kept apart from the slip by several folds of paper about the thickness altogether of the fly's head. The head, with the eyes uppermost, and the tongue protruded towards the right hand, is then placed in a drop of acid under the edge of the presser and held there, and, if necessary, the tongue forced to protrude further by a slight pressure of the fore-finger of the left hand. While in this position the expander, a piece of glass 1 inch long and ¾ of an inch wide, to the under side of which a small covering glass has been fastened by brown cement, and having a piece of paper by which to hold it gummed to the top (Fig. 15), is used to force the lobes of the tongue backwards, that is towards the left hand, and downwards into the required position. The Palpi, which will usually be found lying against the head, may then be arranged by means of a stiff bristle, and the head laid aside for three or four days to set.

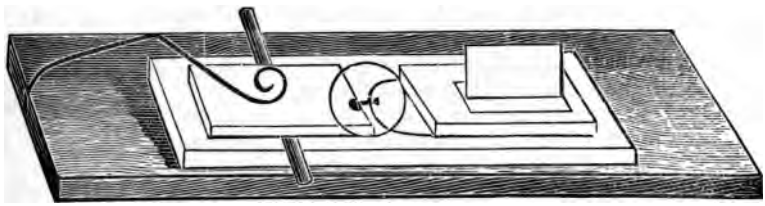

Fig. 15.

Mounting.—After cutting away the head, transfer the tongue which must be kept the same side up, to a drop of fresh acid on the centre of a clean glass slip. This may be done by pushing it on to the end of a quill which has been bent a little at the end, to form a kind of a spoon. Apply balsam at the right-hand side of the cover-glass, and drain off the acid by holding a piece of blotting paper to the opposite edge. If any cloudiness appears, warm the slide a little. A light slip may then be put on, and the slide put aside to harden. No needles should be used in any part of the process.

PROFESSOR ABBE'S TEST OBJECTS.

AT the October meeting of the Royal Microscopical Society, Mr. Ingpen stated that, even amongst those thoroughly familiar with the use of the highest powers, very few would be found capable

of adjusting an objective to the same degree of accuracy as the optician. He believed that with the particular class of objects mentioned by Dr. Dippel no two histological observers would be found to agree as to what was the best correction. He further stated that Prof. Abbe had met that difficulty by proposing a special test object for the purpose, a description of which was being prepared for the Journal. The test plate showed beyond question what the best correction was, so that it was possible for a microscopist to pass a number of objects under the objective and at once determine the best correction for each. Mr. Beck stated that Dr. Dippel, in his remarks for abolishing the correction collar, seemed to be content with inferior definition rather than take the trouble to get the best that was to be obtained. Mr. John Mayall, Junr., concurred in much that Mr. Beck had said, and advised the correction collar to be applied to homogeneous immersion lenses, and the Society would be glad to know that Prof. Abbe himself had so far wavered from his former opinion that he now agreed with Dr. Zeiss, and in future all homogeneous immersions supplied by him would be made with or without correction collar.

We would like to add that ever since their introduction, Dr. J. Edward Smith, who is a splendid manipulator of objectives, has always argued for the addition of the correction collar to homogeneous immersion objectives.—ED.

THE DIAGNOSIS OF BLOOD STAINS.

DR. J. G. RICHARDSON, of Philadelphia, has given the following summary of his measurements of blood corpuscles. It was originally printed in Gaillard's Medical Journal, and reproduced in the American Monthly Microscopical Journal, from whence we take it :—

First—That in unaltered blood-stains, as ordinarily produced by the sprinkling of drops of blood upon clothing, leather, wood, metal, etc., we can, by tinting with anilin or iodine, distinguish human blood-corpuscles from those of the ox, pig, horse, sheep and goat, whenever the question is narrowed down by the circumstances of the case to these limits.

Second—By the method I have devised we can measure the size of the corpuscles, and apply the two corroborative tests of tincture of guaiacum with ozonized ether and of spectrum analysis, to a single particle of blood-clot weighing less than one fifteen-thousandth part of a grain, a quantity barely visible to the naked eye.

Third—Hence, when an ignorant criminal attempts to explain

suspicious blood-spots upon his clothing, weapons, etc., by attributing them to the ox, pig, sheep or goat, or to any of the birds used for food, we can, under favourable circumstances, *absolutely disprove* his false statement, and materially aid the cause of justice by breaking down his lying defence, even if twenty years have elapsed.

Fourth—But, if the accused person ascribes the tell-tale blood to a dog, an elephant, a capybara, or any other animal in Dr. Woodward's list, it is useless to attempt to dispute his story, on microscopical evidence, as to the size of the blood-corpuscles.

Fifth—In cases of innocent persons wrongly accused of murder, and really stained with the blood of an ox, pig, or sheep, testimony of experts, founded upon measurement of the corpuscles, would be valuable, but less conclusive, because, under certain circumstances, human blood-corpuscles may *shrink* to the size of those of the ox, whilst under no known condition do ox or pig corpuscles *expand* to the magnitude of those in human blood.

Sixth—In order to do away with ingenious objections of lawyers that the murdered person may have been affected with some disease which altered the size of his blood disks, or that the articles of clothing, etc., upon which the stains were deposited had produced, chemically or otherwise, some similar change in their magnitudes, it is very important to obtain, promptly, stains from the fresh blood of the victim, made in the presence of witnesses, upon portions of the prisoner's clothing, or weapons analogous to those upon which suspicious red spots are found when he is arrested. When this cannot be done, spots of the murdered person's blood, sprinkled on white paper, and fragments of his lungs and kidneys, should be carefully preserved, the former by a rapid drying and the latter by preservation in diluted alcohol. These little precautions, which may in any instance, prove to be of infinite importance, should be earnestly impressed upon coroners, district attorneys and policemen, throughout the civilized world.

NOTES AND QUERIES.

MICROSCOPICAL SOCIETY FOR BRADFORD.—We have received the printed rules which guide the members of this Society; perhaps we are correct in guessing that a combination of microscopists has only just been formed. If this be so, we wish the Society a long life.

BRAINTREE AND BOCKING MICROSCOPICAL SOCIETY.—The Journal and annual report of this Society has come to hand since our last issue. From it we gather that the following papers were read

during the session: on "Pollen grains" by Miss B. Alcock; on "*Protococcus pluvialis*" Mr. F. Row; on "Crystals" by Mr. E. B. Knobel, who also gave a lecture upon "The Principles of the Spectroscope." Mr. James Harrison gave a paper on "Mounting Microscopical objects"; Mr. Thomas Taylor on "Animal Parasites"; Mr. Wheeler on "Practical Optics"; Mr. F. Row on "Photomicrography"; and Mr. R. W. Davies on "The Honey Bee." A goodly list withal.

THE MICROSCOPE FOR EXAMINING METALS.—Mr. A. Martens, of Berlin, finds that certain peculiarities due to the process of manufacture, or molecular changes due to the manner it is strained, can only, in the case of iron, or steel, be made patent by the use of the microscope. Ordinary microscopes are usually made for objects of very small degrees of thickness, and, therefore, he has devised an instrument for use with the above purpose in view. Artificial light thrown down upon the metal M. Martens finds unnecessary, and he advises the use of lenses with a working distance of about three-eighths of an inch.

BOLTON MICROSCOPICAL SOCIETY.—Since our last issue the Annual Soirèe of this Society has been held, and the success which attended the gathering must have been pleasing to the promoters. After the reading of the report by Mr. W. Rideout, the Hon. Sec., the audience adjourned to the Drill Hall, where the President delivered a very admirable lecture upon Insect Structure, illustrated by transparencies thrown upon the screen by the lime light.

The tables in the Hall were loaded with objects of interest, Mr. Bolton, of Birmingham, with his Living Organisms, Dr. Barron, the demonstrator of anatomy at the Liverpool School of Medicine, showing the bacillus of tuberculosis, anthrax and septicæmia, and many other objects by other exhibitors too numerous to mention. Amongst the other exhibits we noticed three distinct forms of Photo-micrographic apparatus, that of Mr. Shipperbottom being unusually complete.

MANCHESTER CRYPTOGAMIC SOCIETY.—The Ordinary Monthly Meeting was held Nov. 20th, Captain Cunliffe, F.R.M.S., in the chair. The Hon. Sec. placed upon the table the last Part of the New British Moss Flora, by Dr. Braithwaite, which had been presented by the author. A number of freshly-gathered mosses had been sent from Orme's Head by Mr. William Jones, including a few interesting species, which were distributed amongst the members. Mr. Rogers exhibited several interesting Continental species of mosses, which do not fruit, or very rarely so, in England, viz., *Myurella apiculata*, *Lescuria striata*, a specimen of the *Hypnum virescens* (Bowlay), from the Pyrenees, and another specimen of the same species collected by John Nowell at Gordale, Malham, in the

year 1849, but which at that time was known as a variety of *H. commutatum.*

Mr. William Foster exhibited a remarkable variety of the *Polypodium phegopteris*, which he had found in August last at Patterdale. The pinnæ of the fronds were cut up into long narrow lobes, like the variety of *Polypodium vulgare*, known as *Cornubiense.* If the variety proves to be constant it will make a very good addition to the varieties of cultivated ferns.

MANCHESTER MICROSCOPICAL SOCIETY.—At the last meeting of this Society, held on December 7th, after the usual business, Mr. George E. Davis, F.R.M.S., read the second part of his paper on "Elements of Microscopy: Some of the properties of plates, prisms and lenses." The paper was well illustrated by lantern slides ably manipulated by Mr. Bathe. [This paper will subsequently appear in full.]

The meeting of the Mounting Class was held on Wednesday evening, the 13th December. Mr. Aylward's new dissecting table was shown, and from a hint thrown out by Mr. Lofthouse at the previous meeting, the Secretary exhibited a table showing the utility of the common metal pencil case provided with a spiral; it makes an excellent coarse adjustment for carrying the pocket lens, and is easily attached to any table.

In the junior division Mr. Miles then proceeded with white zinc cement ringing, explaining during the process what ought to be avoided, and showing that the method is not to build up, as is generally supposed, but to apply the brush to the edge of the cover glass and allow the cement to gradually fall by its own weight; he also showed the ornamentation of several slides by means of colored rings.

In the senior division Mr. A. J. Doherty, whose slides we have often had occasion to admire, went carefully through the various processes of decolorization, washing, preparing, staining in carmine, then in aniline green and mounting in balsam, and was very successful with several slides of the sugar cane. He also explained the various tissues acted upon by the different colouring media, and supplied those present with the formularies he has found from experience to give the best results.

Exceedingly instructive and interesting are double-stained sections, and when we consider that they offer no very great difficulties to the microscopist, it is a matter of surprise that individual mounts are not more general.

For those who care to follow out this beautiful process, an exhaustive paper by Mr. Doherty will be found in the Northern Microscopist, vol. I., page 128.

MR. COLE'S STUDIES.—According to promise, No. 29 of this

series contains a T. S. section of Human Pancreas, stained with carmine, and of which the chromo is very well executed. No. 30 contains a folding plate, illustrative of lichens and lichen structure, and the digest of Schwendener's theory, so that this number recommends itself to those interested in lichens. We have a strong dislike *always* to folding plates, but our objection in this case is nearly overcome by the excellence of its details. No. 31 is devoted to the T. S. section of Human Pancreas injected with carmine, and in the "Methods of Preparation" it is stated that the injection mass devised by Dr. Carter of Leamington is the best for the purpose.

BACILLARIA PARADOXA.—Mr. Robt. C. Douglas, in the December number of the Journal of Postal Microscopical Society, states, "that in 1851 he found this diatom in the ditches intersecting swampy meadows on both sides of the river just above the town of Stafford," and another correspondent, Mr. E. Bostock, states, "that there seems little doubt this diatom is more generally distributed than is supposed, for, in addition to the locality mentioned by Mr. Douglas, it is noted in 'Practical Microscopy' as having been found attached to algæ taken from the canal at Birmingham." The latter correspondent fairly assumes, "it is quite possible that so far as the canal is concerned the diatom may have been imported, but, on the other hand, the fact of its being found in ditches around Stafford is against that view. It can, however, no longer be correct to describe it as it is at the present time in existing authorities as a purely *marine* organism."

Bacillaria paradoxa was found by Professor Marcus Hartog in 1880 in a fresh water well at Penmaenmawr, North Wales.—ED.

TO MOUNT IN GLYCERINE.—Heat india rubber till it becomes sticky, then dissolve it in benzole; put a ring of this both on cover and slide, then let it remain till tacky; place the object in glycerine, float it on if convenient, arrange it and place, and press down the cover, wash away spare glycerine and run asphalte varnish or any other finish as preferred and the slide is finished. The advantages are the india rubber sticks in spite of the glycerine and is elastic, and so a great amount of trouble is saved.—*J. G. P. Vereker, in the Journal of the Postal Microscopical Society.*

MR. BOLTON'S STUDIO.—We have received from Mr. T. Bolton, Naturalist, of No. 57, Newhall Street, Birmingham, a circular from which we regret to learn that his Studio has not been supported in a measure to be of the remunerative character it deserves, and soliciting an accession of fresh subscribers, and the continuance of the support of the old ones,—to use the language of Mr. E. Ray Lankester (no mean authority), "Mr. Bolton has conferred large benefits upon naturalists by his excellent agency for the supply of

microscopic and other living organisms," and we cordially hope our readers will avail themselves of them in the future.

LIVERPOOL ASSOCIATED SOIREE.—On Wednesday, Dec. 20th, the learned and Scientific Societies of Liverpool held their Annual Soiree at St. George's Hall, at which, amongst various other lectures and papers upon scientific subjects read on the occasion, was an interesting lecture upon "The Transformation of Insects," as exemplified in the silk worm, the gnat, and the locust, by Dr. Hicks, which was illustrated by drawings shewn by the lime light, and another by Professor H. N. Moseley, on "Life in the Surface Waters of the Ocean." The objects exhibited ranged over a large and extended field of science and art. The exhibition of Microscopic objects by the members of the Microscopical Society of Liverpool and the Chester Society of Natural Science were of the usual satisfactory character: Mr. T. S. Shepheard, of Chester, exhibited the rare rotifer *Pedalion mira*, and amongst the miscellaneous objects might be found a selection of botanical slides, by Mr. C. Vance Smith, illustrating the works of Sach and Thomè, and a series of original drawings from the microscope, by Mr. Rochfort Connor, illustrative of the adulteration of tobacco, snuff, beer, pepper, tea, coffee, and other excisable commodities, which had been kindly lent by Dr. J. Bell, of the Inland Revenue Laboratory, and which drawings, we were informed, are the standards of reference at Somerset House.

The Soiree was attended with its usual success, and we think that the example of an "Associated Soiree" of Scientific Societies might be successfully and very advantageously followed by other large cities and towns.

DIATOMS.—Gomphonema Geminatum—remarkably pure gathering. Sample tube for 3 microscopic slides, one inch, for 12 best slides. M—, 106, Princes-street, Edinburgh.

WANTED.—Lichens, mounted or unmounted; liberal exchange in slides or material. Arthur J. Doherty, 25, Barton-street, Mossside, Manchester.

WANTED.—Lantern slides. Offer, micro. slides, material, intensity coil, books. F. S. Lyddon, 2, Oakland Villas, Redland, Bristol.

FOR SALE.—Small Microscope. by Powell and Lealand; lever movement to stage; 1 inch and $\frac{1}{4}$ inch objectives; two eye-pieces, &c., in box. Price £8. M.D., The Priory, Lower Sydenham.

FOR SALE.—Ross Model Monocular Microscope, by Steward, best make. Glass sliding stage, B eye-piece, draw tube for full size oculars, polariscope, spot lens, adapters, double nose piece and two cabinets. Cost over £12. Is guaranteed new. Owner having a Binocular, will sell for half price. K. H., care of Editor.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 26. *FEBRUARY.* 1883.

ON DR. CARPENTER'S ADDRESS.*

BY W. BLACKBURN, F.R.M.S.

EACH member of the Society has, I believe, received a copy of the address which Dr. Carpenter delivered at Montreal in August last, to the Histological and Microscopical Section of the American Association for the Advancement of Science. For this we are indebted to Mr. Miles, who calls our attention, in an accompanying letter, to certain passages having reference to "diatom tests" and "the best objectives for biological work."

There is much in the Address of which I think no microscopist will disapprove. Its general tenor, however, is to depreciate the value of lenses of wide aperture, and as we are now beginning to appreciate the true value of such lenses, owing to the researches of Prof. Abbe, I would direct your attention to some of the statements with which Dr. Carpenter is credited, as they appear to me to be inconsistent with observation and theory. The Doctor warns American microscopists that they are now "going over the track which the English passed over twenty or twenty-five years ago, and have now abandoned," because they "found no valuable result to biological research." If this statement is true, I think it ought to stand the test of a comparison of the apertures prevailing at that period with those in general use now. It must not, however, be overlooked that in *high* powers *immersion* lenses are more frequently used now than they formerly were, and that a dry lens of 175° has a smaller *real* aperture than a water-immersion lens of 97°, or a homogeneous-immersion one of 82°. The lens of widest aperture ever constructed in this country is a one-eighth, recently made by Messrs. Powell and Lealand, having an angle of 150° in oil (N.A. 1.47), and a resolving power 47 per cent. higher than a dry

* Remarks made to the Manchester Microscopical Society on January 4th.

lens of 175°. Our comparison, therefore, may be confined to the low and medium powers.

In 1855, Mr. Andrew Ross produced a new series of objectives, viz.: 1 inch of 15° and 22°; ½ in. of 65°; ¼ in. of 85° and 125°; ⅛ in. of 135°; ⅛ in. of 130° and 150°. He had previously produced a one-inch of 27°. About this time Messrs. Smith and Beck produced a $\frac{4}{10}$ths of 90°. The Micrographic Dictionary for 1860 tells us that the lenses then in use had the following angular apertures:—2 in. or 1½ in. 12° to 20°; 1 in. or ⅔ in. 22° to 35°; ½ or $\frac{4}{10}$ in. 65°; ¼ in. 75° to 140°; ⅛ in. 110° to 150°. As far as I can ascertain, they represent the common apertures of the period alluded to in the Address. They are all made at the present day, and in some instances are much exceeded.

Mr. Tolles, of Boston, U. S. A., now makes the following lenses: $\frac{4}{10}$ inch up to 145°, ¼ inch up to 180°. He has recently made a $\frac{2}{5}$ inch of 70°, which is said to resolve *Pleurosigma angulatum* without a condenser. Mr. Spencer, of Geneva, N. Y., makes a 1 inch of 50°, ½ inch of 100°, and ¼ inch of 180°. Dr. J. Edwards Smith, Professor of Histology at Cleveland, Ohio, in his work, "How to See with the Microscope," recommends, for *ordinary biological work*, a one-inch or two-thirds objective of 45° or 50°, a one-sixth of 87° to 95° balsam-angle (N.A. 1.05 to 1.13), a one-tenth of 100° balsam-angle (N.A. 1.17), and a dry one-half inch of 38° for work over chemical re-agents. I think it can scarcely be said that this represents a phase of experience through which microscopists have passed in this country.

The Address tells us that "increased angle has given us great power of resolution, but what else? Nothing at all." Against this I would place a statement made in the last edition of the Doctor's work, "The Microscope and its Revelations," in which he says, "It is clear that the representations of minute structure given by objectives of *widest* aperture are *more trustworthy* than those given by those of *narrower*."

The Address also tells us that "the flagella of *Monas termo* would probably not have been found without the wide-angle lens, but now they are known to exist, they have been seen better with a lower angle." Theory tells us that the reverse of this ought to be the case, and in Prof. P. Martin Duncan's presidential address to the R.M.S. we find these words:—"In searching through a stratum of fluid for bacteria a wide aperture would be unnecessary, but when a particular bacterium is found, it is only that which will give us an accurate view of its flagellum."

The Doctor is careful to depreciate wide apertures on account of the accompanying loss of penetration, and instances the "high biological work" of Mr. Dallinger and Dr. Drysdale as having been accomplished with a dry $\frac{1}{25}$ inch of 140°. For a more cor-

rect view of the biological work of Mr. Dallinger I would refer you to the letter he wrote to Mr. Miles, which was published in "The Northern Microscopist" for last October, in which he states, "No one has ever appreciated or found more pleasure and profit in the use of the large angles with which our lenses have been more and more perfectly provided for the last ten or twelve years than I have. As they have been produced I have obtained them each and all that had any real value." . . . "Much that had been done could never have been done without them." . . . "The homogeneous lenses have given me splendid results, some of which will shortly be published; but no immersion lens of any kind could be used to work out to the end an organic life history,—that is, if it involved life and movement,—because, the object being in a limited area, and possibly in fluid, the fluid *under* the cover does (when the movements of the object are followed) at length, without the spectator's knowledge, mingle with the fluid *above* employed for the lens, and thus destroy the whole object of search and study." This, however, is no argument against the use of immersion lenses on preserved specimens.

Dr. Carpenter tells us in the Address that he holds "the Podura scale as the best test of an objective for biological research;" and again, "a good 2 inch should resolve the Podura scale with sufficient magnification from the eye-piece." He has taught us in his "Revelations" that it requires a $\frac{4}{10}$ths to resolve the larger scales. Now, if we want a 2 inch to do the work of a higher power, we must extend its aperture; but this can only be done at the expense of that quality of penetration which the Address advocates so strongly, and without which the Doctor considers that a lens must be an "inferior" one. With a low power the so-called "notes of exclamation" on the larger scales are seen as fine lines only, and Prof. Abbe's theory of microscopical vision may be usefully summoned to our aid in order to ascertain the theoretical aperture that is capable of resolving them. From my own measurements of several of the larger scales on one of Topping's slides I have come to the conclusion that a resolving power which may be expressed in the number of lines to an inch as varying from 20,000 to 25,000 is necessary to separate the marks on these scales. Now, the aperture required to give this power of resolution ranges from $24\frac{1}{2}^{\circ}$ to 31°, an aperture which is possessed by no two-inch lens made in this country; but in America these lenses are made with angular apertures ranging up to 25°, and they ought therefore to resolve some of the coarser scales. According to Prof. Abbe, the capacity of the eye for distinguishing lines in close parallel approximation varies in individual observers, those of keen sight being able to see a space having an angular extension of two minutes, whereas others may require double that quantity. This

is equivalent to the visibility of parallel lines, at ten inches distance from the unaided eye, having a separation ranging from $\frac{1}{172}$ to $\frac{1}{86}$ of an inch, and this estimate may form the basis for a calculation of the magnifying power required by different observers in order to see lines having a separation amounting to $\frac{1}{20000}$ of an inch. We, therefore, find that an amplification ranging from 116 to 232 diameters is necessary to resolve such lines, and that a two-inch objective of the very wide angular aperture of 25° will require eye-pieces equal in power to Ross's E or F, the latter being the most powerful one made in this country, and that in some cases even this will be insufficient to meet the requirements of individual observers, and the draw-tube will have to be used in order to obtain the large amplification of 232 diameters. Powell and Lealand's highest eye-piece yields only 150 diameters with a two-inch objective. Is it not possible that the Doctor may have been charmed with the well-defined images produced by some of the wide-angled lenses of the transatlantic opticians? But what does *theory* say as to their penetrating power? A first-class two-inch lens in this country should have an angle of 14°, and *focal depth* in the monocular instrument (under similar conditions of magnifying power, illumination of the object, &c.) is in the inverse ratio of the numerical aperture. Therefore, if this quality in the English two-inch lens be expressed by 1.0, in the American lens of 25° it must be expressed by .56, or little more than one-half. In order to resolve 25,000 lines to the inch an angular aperture of 31° will be required, and an amplification of from 145 to 290 diameters, and these conditions may be obtained in our English $\frac{2}{3}$rds objective and Ross's C and D eye-pieces.

Thus *theory* shows that the lowest powers in use in this country that can be expected to resolve the larger Podura scales are the best one-inch and two-thirds objectives, with amplifications of 116 to 290 diameters. This will, I think, be found to accord with observation. Some of you may think that a better test for a two-inch lens for *ordinary biological work* is the old-fashioned one of an opaque injection, or the pollen of the Mallow *in situ* upon the anther. For my own part, I prefer still to attach my faith to the "Revelations," rather than adhere to their author's latest dicta as to "the best objectives for biological work."

MOSS DEVELOPMENT.

By William Stanley.

(Continued from page 15.)

THE sexual organs of Mosses, with the exception of the male branches of Sphagnum, usually occur in considerable numbers at the end of a leafy axis, surrounded by leaves often of a peculiar shape and mixed with paraphyses, and the whole group of organs, which may be termed a receptacle, either terminates the growth of a primary stem, as in the Acrocarpous Mosses; or, as in the Pleurocarpous Mosses, the receptacle is placed at the end of a stem of the second or third order.

The receptacle may contain either one kind of sexual organ only, in which case it is either monoicous or dioicous, or it may contain both antheridia and archegonia, and is then termed bisexual or synoicous.

In *Funaria hygrometrica*, *Dicranum undulatum*, &c., the male receptacles appear on smaller plants with a shorter duration of life, and the habit of the male flowers is altogether different from that of the synoicous or bisexual inflorescence.

In the synoicous plant the archegonia and antheridia occur close to one another, at the summit of the stem, in the centre of the envelope (Perichætium), either in two groups, or separated by peculiar enveloping leaves, and the antheridia stand in the axils of these, arranged in a spiral surrounding the central group of the archegonia.

In the female and synoicous inflorescence the form of the Perichætium is that of an elongated, almost closed bud, the leaves of which grow very vigorously after fertilization, while the male Perichætium consists of broader, firmer leaves, and is of three different forms. Usually it is bud-shaped, and, when lateral, its leaves decrease in size towards the outside. Secondly,—When terminal on a stouter shoot and globular, it is shaped like a capitulum, and sometimes borne on a naked pedicel, as in Tayloria, Splachnum, &c. Thirdly,—It is sometimes discoid, and consists of leaves very different from the foliage leaves, being broader and shorter, and always smaller the nearer the leaf spiral approaches the centre. The antheridia stand in their axils, Mnium, Polytrichum, Pogonatum, Dawsonia.

The paraphyses stand between or by the side of the sexual organs, their function being to preserve the vitality of the antheridia and archegonia by keeping up a certain amount of moisture.

In the female receptacle they are always articulated filaments;

in the male filiform or spathulate, and consisting in the upper part of several rows of cells. Paraphyses are wanting in the closed bud-like flowers of Hypnum.

The male organs, or Antheridia, consist of cellular sacs, containing chlorophyll granules, and are of an elongated club shape, assuming, when ripe, a red or yellow colour, and opened by a slit across the apex, through which the antherozoids, still enclosed in their mother cells, are discharged as a thick jelly, which dissolves

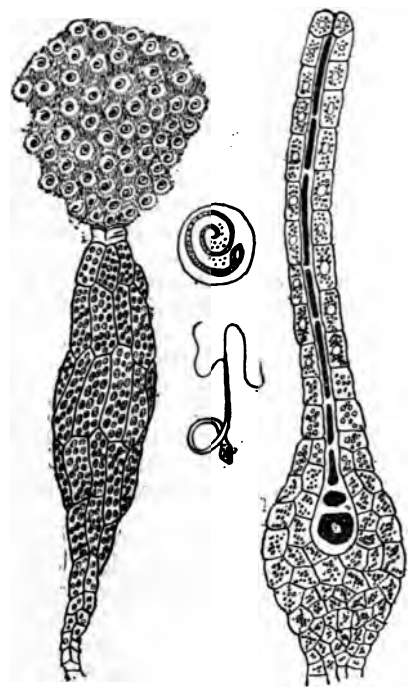

Fig. 16.

in water which allows the antherozoids to escape and swim about free. Fig. 16.

In the Sphagnaceæ the antheridia are nearly spherical, and open in the same manner as the Hepaticæ, the escape of the mother cells being occasioned by the access of water and the falling away from one another of the cells of the wall. The careful investigations of Leitgeb show that the origin of the antheridia are very various.

The female organ, or archegonium, is flask-shaped, and according to Wurzburg, always arises in typical mosses from the apical cell of the shoot. It consists of a broad base supporting a roundish ovoid portion, above which rises a long, thin neck, generally twisted on its axis. The wall of the rounded portion consists of a double layer of cells, and passes up continuously into the wall of the neck, composed of a single layer of cells of from four to six rows.

Together they enclose an axial row of cells, the lowest of which is ovoid, and produces the oosphere. When mature, the axial cells become mucilaginous, and force open the four uppermost or stigmatic cells of the neck, thus allowing the antherozoids to penetrate to the oosphere. Fig. 16. The conversion into mucilage of the canal cells and the opening of the neck take place in the same manner in the Hepaticæ or Liverworts.

The fertilized oosphere results in the Sporogonium, which grows by elongation, and long before the formation of the spore capsule tears away from its base the ventral portion of the archegonium, forming the calyptra or hood; the neck of the archegonium assumes a deep red-brown colour, and for some time crowns the apex of the calyptra. The sporogonium of all mosses consists of a stalk (seta) and the spore capsule (Theca or Urn), but the former is very short in Sphagnum, Andrea, and Archidium; longer in most other genera and with its base planted in the tissue of the stem, which after fertilization, grows luxuriantly beneath and around the archegonium, forming a sheathlike investment, the Vaginula. The unfertilized archegonia may frequently be seen on the exterior of the Vaginula, as only one archegonium is usually fertilized in the same receptacle.

The capsule has in all Mosses a wall consisting of several layers of cells and a distinct epidermis, which sometimes possesses stomata of a peculiar character. The whole of the inner tissue is never used up in the formation of spores; a large part of the central tissue remains as a Columella, round which the mother cells of the spores are formed.

The structure of the mature capsule, and especially the contrivances for dispersing the spores are different in the various principal sections of Mosses, and are the means by which we arrive at the distinctive characters of the larger natural systematic groups. The origin of the sporogonium does not afford any great variety.

The oospore of the fertilized oosphere is first of all clothed with a cell wall; continues to grow considerably, and is then divided by a horizontal or slightly oblique wall. The lower of these two cells undergoes only one or two divisions, and contributes but little to the formation of the embryo.

The upper gives rise to the capsule and the seta; a two-sided apical cell being formed in it by means of the oblique divisions.

Hoffmeister states that in *Bryum argenteum* the upper cell is divided once or twice by horizontal septa before the first oblique division, while in Phascum and Andrea this oblique septum is found immediately after the first horizontal one. The apical cell now forms two rows of segments by partition walls inclined alternately, and these segments are next divided by radial vertical walls, followed by further numerous transverse divisions. By this process the young sporogonium is transformed into a multi-cellular body which is usually fusiform, the lower end not participating in the growth in length, although a swelling of this lower end takes place in certain cases of Sphagnum, Archidium, and Phascum, such as usually occurs in the Hepaticæ.

The apex now becomes inactive, and beneath it the capsule is formed as a spherical, ovoid, cylindrical, or frequently unsymmetrical swelling, which originates in the typical Mosses only after the elongation of the fusiform or cylindrical sporogonium, and after the raising up of the calyptra.

This mass of homogeneous tissue presents at an early stage a differentiation into an amphithecium from which the wall of the capsule and of the spore-sac are derived, and a central endothecium corresponding to the future columella and sporogeneous layer or mother cells of the spores, which first of all become isolated and then divide, so as to form four spores.

The contents of the mother cell begin to divide into two, but this bi-partition is usually not completed, the division into four taking place at once, and the preparation for the formation of spores takes place simultaneously everywhere within the same capsule.

The ripe spores are roundish or tetrahedral, surrounded by a thin finely granulated exospore, which is of a yellowish, brownish, or purple colour, and besides protoplasm, they contain chlorophyll and oil. According to Lehimper the size of the spore is extremely variable. In Archidium, where only sixteen are found in each capsule, they are about $\frac{1}{125}$ inch in size, while in the highly-developed Dawsonia they scarcely attain $\frac{1}{5000}$ inch. When kept dry the spores often retain their power of germination for a long time, but when moist they frequently germinate after a few days; those of Sphagnum after two or three months.

The time necessary for the formation of the sporogonium varies greatly in the different species, but is usually very long in comparison with the small size of the body concerned. The Pottia blossoms in summer, and ripens its spores in winter; the Funaria are perennially in blossom, and have constantly sporogonia in all stages of development, each occupying for its completion probably two or three months. *Phascum cuspidatum* develops in the autumn from its perennial underground protonema, and ripens its

spores in a few weeks before the winter. The bog Hypna, on the other hand, *H. giganteum*, *H. cordifolium*, *H. cuspidatum*, *H. nitens*, &c., blossom in August and September, and ripen their spores in July of the next year; they often require ten months for the development of their sporogonia. *H. cupressiforme* bears in autumn at the same time sexual organs and ripe spores, and hence requires one year. The same length of time is required for Philonotis, and by some species of Bryum and some of Polytrichum, which blossom in May and June.

Of the larger natural systematic groups, the Sphagnaceæ, or Bog Mosses, consisting of one genus, first claim our attention.

Only when the spores germinate in water is a branched protonema developed, the usual form being a flat protonemal expansion, as in Fig. 12, on which the leaf-buds appear, and which produce root-hairs only in the young state.

The stem, as it increases in strength, produces laterally by the side of every fourth leaf, a very much divided branch. These tufts of branches form a compact mass at the summit of the stem, but lower down are more distant from each other. The leaves spring from the stem and the branches from a broad base, with a divergence of $\frac{2}{5}$; they are tongue-shaped or apiculate, and are composed of two kinds of cells arranged regularly, large broad cells and narrow tubular cells running between the former, and connected with one another into a net-work.

The larger cells show irregular narrow spiral bands, also large circular holes; otherwise they are empty and colourless, while the tubular cells retain their contents, form chlorophyll granules, and thus constitute the functional tissue of the leaf.

The stems consist of three layers of tissue; an axial cylinder of thin-walled parenchymatous cells, enveloped by a layer of thick-walled, dotted, prosenchymatous cells, with their walls coloured brown, while the epidermal tissue consists of from 1 to 4 broad thin-walled empty cells, possessing in *Sphagnum cymbifolium* spiral thickenings and large openings similar to the leaves.

The colourless cells of the leaves and of the epidermal tissue of the stem, serve as a capillary apparatus for the plant, through which the water in the bogs in which it grows is raised up and carried to the upper parts; hence Sphagnum, which always grows erect, are penetrated with water to their very summits like a sponge, even when their tufts stand high above the surface of the water.

The antheridia and archegonia are always distributed on different branches, and sometimes on different plants when they form large distinct patches. They arise on the fascicled branches as long as they are near the summit of the primary stem and belong to the terminal tuft, and their time of bearing is mostly autumn and winter.

The male branches are generally conspicuous and easily recognized, the leaves being yellow, bright red, or especially dark green.

The antheridia stand on the mature shoot by the side of the leaves; they are never terminal, and are found only in the middle part of the male branch, one standing beside each leaf. The archegonia arise at the apex of the female branch, exactly like those of the rest of the Mosses; but the development of the sporogonium is marked by the elongation of the summit of the stem into a long, naked receptacle, which elevates the capsule contained in the calyptra high above the perichætium.

This so-called pseudopodium must not, therefore, be confounded with the seta of other Mosses.

The spore mother-cells are formed from a cap-shaped layer of cells beneath the apex of the spherical theca, the inner tissue beneath it forming a low hemispherical column not reaching to the apex. The spores are regularly formed, but there occur in addition smaller spores, termed sporogonia.

The capsule opens by the detachment as a lid of the upper segment, and the calyptra is ruptured irregularly.

The second natural group is the Andreæaceæ, small cæspitose Mosses, very leafy and much branched.

The elevation of the shortly-stalked theca on a leafless pseudopodium and the formation of the spores and central tissue is the same as in the Sphagnaceæ, but the capsule opens by four horizontal slits at the side, and not by an operculum or lid; thus four valves are formed, united at the apex and at the base, which are closed in damp but open in dry weather.

The third natural group is the Phascaceæ, Earth Mosses, they are very small plants, whose short stems remain attached to the protonema until the spores are ripe.

The capsule in its internal differentiation agrees with that of the typical Mosses, being distinguished from them by not opening with a lid, but allowing the spores to escape only by its own decay.

In the fourth natural group, the Bryaceæ, or True Mosses, the sporogonium is always stalked, and the seta is usually of considerable length; the capsule always opens by a detachment of its upper part as a lid (operculum); the operculum is either simply and smoothly separated from the capsule, or a layer of epidermal cells by the swelling of their inner walls forms an annulus or ring, and in this manner separate the lid from the capsule.

Most commonly after the lid has fallen off, the margin of the capsule is seen to be furnished with one or two rows of elegant and regular teeth or cilia forming the peristome; but if the peristome is seen to be wanting, the capsule is said to be gymnostomous.

The capsule is at first a solid homogeneous mass of tissue; the differentiation of its interior begins with the formation of an intercellular space, which separates several layers of cells and forms the wall of the capsule; but the wall remains attached above and below to the columella.

The intercellular space is traversed by rows of cells which stretch across from the wall of the capsule the inner mass of tissue, and the outer layer of the cell wall is developed into a distinctly cuticled epiderm.

The first two or three layers of the inner mass of tissue forms the spore-sac, while the third or fourth layer produces the mother cells of the spores, and this layer of cells is first of all distinguished by being densely filled with protoplasm in which lies a large central nucleus.

The mother-cells of the spores, after isolation, float in the fluid contained in the spore-sac until they form the spores by repeated division.

The inner large-celled tissue, which contains but little chlorophyll, and is surrounded on all sides by the spore-sac, is distinguished as the Columella. The spore-sac is ruptured by the casting off of the operculum, but the columella remains dried up, and in Polytrichum there remains also a layer of cells the Epiphragm, attached to the points of the teeth of the peristome, and covering the opening of the capsule.

THE SCHWENDENERIAN THEORY OF LICHENS.

WITHIN the last few years the opinions of scientific men have been much divided upon the question of the true nature and character of Lichens, and, judging the subject to be one of interest to microscopists generally, we venture to ask our readers to devote with us a short time to its consideration.

Until about the year 1869, Lichens were universally regarded as a distinct order of plants, occupying a position between Algæ and Fungi, and constituting the class *Lichenes* in the common classification. In 1869, however, Schwendener propounded the then startling theory that Lichens were not autonomous plants at all, but simply aggregations of discomycetous Fungi living as parasites upon Algæ—represented by the gonidia of the compound organism. This theory has found many supporters, amongst the most eminent being Mons. de Bary, Max Rees, E. Bornet, and Treub. The foundations for the hypothesis are mainly the following. It has

been asserted that the existence of a genetic relationship between the gonidia and the hyphæ has never been proved—in fact that there is none, and that the gonidial elements may all be referred to some well-known group in the *Algæ*. Rees has attempted to form a Lichen by synthesis from the distinct algal and fungoid elements, and his experiments, though not absolutely successful, have yielded results which he can only explain by taking the dual nature of Lichens for granted. Again, Stahl, in 1877, succeeded in producing a Lichen from the spores and hymenial gonidia of *Endocarpon pusillum*, which developed perithecia and spermogonia. It has also been found that the same Lichen thallus may contain widely differing species of *Algæ* associated together, while on the other hand the same *Alga* may occur in perfectly distinct Lichens. These facts, and others which we have not space to mention, undoubtedly help to make a strong case for the theory, but its opponents are many in number, and they have very weighty arguments to bring forward against it. Dr. Minks seems to have proved conclusively that there *is* a genetic relationship between the gonidia and the hyphæ, as he has detected in all the parts of the latter certain small bodies which he calls *microgonidia*, some of which develope a membrane and eventually become true gonidia.

These results of Dr. Minks have been strikingly confirmed by Dr. J. Muller, of Geneva. This gentleman recently found a specimen of *Cœnogonium pannosum* in which one of the large filaments bearing the gonidia suddenly narrowed into the ordinary hyphal filament, and in this latter he was able to clearly distinguish microgonidia—gonidia in embryo. If the Schwendenerian hypothesis were correct, the broad part of this tube should be in *Alga*, and the narrower part in *Fungus;* but Dr. Muller, regarding this as an absurdity, views them as different stages in the evolution of one and the same individual. Nylander has remarked, too, that the gonidia are essential to, and take an active part in, the life of the Lichen, which does not authorise us in considering it merely as the host of a parasitic fungus; and, moreover, the size of the host would be so disproportionate to that of the parasite, that, as Cooke says, it would be a case of an elephant parasitic upon a flea. In all other cases of parasitism the host is destroyed to provide for the support of his guest; but here, it is affirmed, we have an exception, and the Alga, so far from suffering, receives an increase of strength and vitality from the draining of its juices by the fungus.

Then, again, if the theory holds good we must assume that the Fungus has very abnormal powers and properties conferred upon it by its singular mode of living. Thus Discomycetous Fungi are annual and short-lived; Lichens are perennial and attain a great age. Fungi prefer moisture and thrive best in the dark; whereas Lichens will flourish in the most open and arid situations. Their

capability, too, of supporting great extremes of cold separate them from the Fungi with which they are asserted to be identical. There are also anatomical differences between the hyphæ of *Lichens* and *Fungi*, which we hardly think it necessary to discuss here. From what we have said, and from the arguments adduced on either side, it will be evident that the question is by no means settled yet, nor indeed can it be till more observations have been made in this direction, and our knowledge is proportionately extended. Above all, we must approach the subject with an unbiassed mind, prepared to receive what Science reveals and Fact establishes, not hastily laying the foundation of our opinion on the unproved hypotheses of either party, but doing our utmost to vindicate the truth whichever way it may lead us, and to remove, if possible, the necessity of any hypothesis at all.

THE MARINE DREDGE,

AS AN IMPLEMENT FOR COLLECTING MATERIAL FOR MICROSCOPICAL AND ZOOLOGICAL STUDY.

By Herbert C. Chadwick, F.R.M.S.

FOR several years previous to 1878, I spent my annual holiday at various places on the North Wales coast, and by systematic shore collecting became tolerably well acquainted with the littoral fauna of the places visited, but was still anxious to extend my operations to the ground below low-water mark.

To do this, a dredge was, of course, necessary; and in the spring of the above-mentioned year, after looking into various books for information upon the construction of dredges, I determined to write to the editor of "Science Gossip," with a view of eliciting some practical hints from his correspondents. A query which appeared in the March number of that Journal rendered, however, this unnecessary, and resulted in a reply from Mr. E. Lovett, of Croydon, in which he recommended a dredge of hempen tangles, such as were used, in addition to the ordinary form, during dredging cruises of the Porcupine and Lightning, and subsequently by the late Sir Wyville Thomson, during the cruise of the Challenger.

Not clearly understanding how Mr. Lovett would construct a dredge of such material, I wrote to him for further particulars, and the construction of the tangle dredge, which I will now attempt to describe, is the result of several suggestions made in his reply.

The figures refer to engravings in "Science Gossip" for 1878, which may be found on page 221.

Figure 185 is a piece of brass wire, about the thickness of a lead pencil, and 16 inches long, each end of which is firmly soldered into a boat-shaped piece of lead, BB, 4 inches in length. Lengthwise, through each piece of lead, a piece of brass wire, CC, about half the thickness of A, and 10 inches long, is fastened, with the ends bent round in the form of a ring. D is a V shaped piece of brass wire, of the same thickness as C, the two arms of which are each 15 inches long, and the ends are firmly hooked to the rings of CC. To this the towing-line is tied. To the bar, A, bundles of untwisted rope, 4 feet long, are tied. Fig. 187 shows the bar and the runners in section, and it will be seen that the bar is bent upwards to allow of its passage over large specimens without injuring them by its weight.

Experience has taught me that this form of dredge is by far the best for echinoderms. I have taken as many as nine specimens of the brittle star-fish *Ophiocoma rosula* at one haul, not one of which was injured in any way. By means of a pair of strong scissors, the specimens may be cut away from the tangles, and if they are intended for the cabinet, the fragments of hemp-fibre may be afterwards removed at the student's leisure by means of a pair of forceps. I found it necessary to provide myself with a duplicate

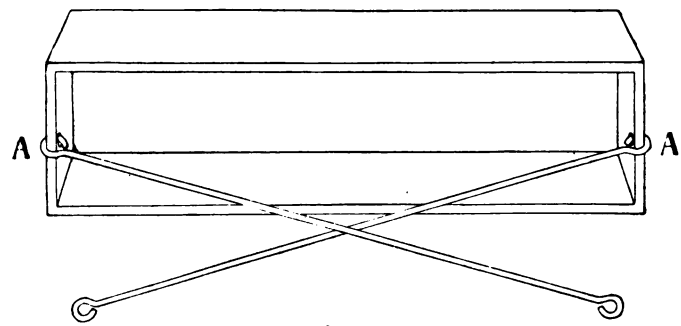

Fig. 17.

set of tangles, as, after a large number of specimens have been taken, they become matted together, or so much may have been cut away as to render them useless.

This form of dredge is, however, of very little value when the larger forms of crustacea, molluscs, and polyzoa are desired, so two years ago I had a small dredge made, the general plan of which will be found figured and described in Woodward's "Manual of the Mollusca," and it has answered my purpose well.

The frame, or "scraper" as it is called, Fig. 17, is of iron, is 12 inches long, 3¾ inches deep, and 1½ inches broad. In front, and exactly in the middle of the two sides AA, a hole is drilled, into each of which a piece of strong iron wire, of the same length as the frame, is hooked, and the free end of each piece is bent in the form of a ring. To the two rings the towing line is tied. A writer in "Science Gossip" recommends that the line should be attached to

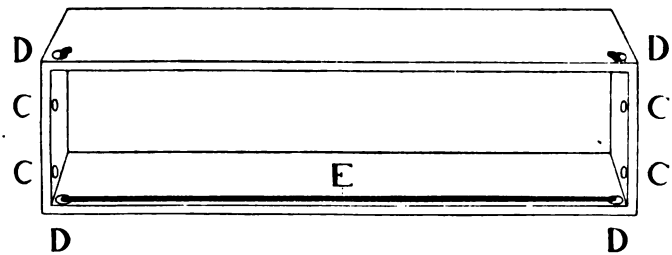

Fig. 18.

one ring only, the two rings being tied together with a piece of spun yarn: this arrangement being said to facilitate the liberation of the dredge when it gets fast to a stone. I have never found any difficulty in liberating the dredge by retracing ground, but I am assured that the above arrangement is of great utility when working over very rocky ground. At the back of the scraper, Fig. 18, four holes are drilled on each side, those marked DD receiving the

Fig. 19.

ends of the two lengths of strong brass wire, EE, which hold the net on to the frame, and into those marked CC, two V shaped pieces of brass wire, F, Fig. 19, are fastened, the object of which is to prevent the scraper from falling on its back, and so closing the mouth of the net. The net is an ordinary landing net of the best quality. It is important that the material of which the net is made should be very strong, on account of the wear and tear to which it is subjected; and when new, the mouth should be considerably wider than the frame, to allow for the shrinkage which takes place after it has been in the water some time. It is also an advantage to

have the width uniform throughout. The towing line which I used is made of linen stay-cord, waterproofed. Though rather thin, I found it to be quite strong enough for use with both the dredges I have described. On one occasion the dredge fouled, and though the tide was running at a considerable rate, and the boat twelve feet long and a rather heavy one, the line stood the strain for nearly ten minutes without showing any signs of breaking. For a dredge of larger size, say 18 inches in width, unless used from a boat of large size, and in water over ten fathoms in depth, I should use the best and thickest linen blind-cord, waterproofed. The use of a thick rope is unnecessary for small dredges. When the dredge is put into the water, the boat should be pulled rapidly for a minute or two; the line being allowed to run slowly through the hands until the dredge falls to the bottom; and as soon as the length of line run out is twice or three times the depth of the water dredged, the boat may be allowed to drift with the tide, or gently pulled if the tide is sluggish. The line should be held in the hands, and let go instantly, when a sudden strain indicates that the dredge has fouled. Sometimes a smart pull will liberate it; but it is generally necessary to re-trace the ground. A good knowledge of the nature of the sea bottom is very essential to successful dredging, and if it is necessary to engage a boatman, a preliminary trial trip should be made before finally engaging him, in order to test his knowledge and abilities. During my last visit to the Menai Straits, I was very fortunate in this respect. Boatmen who collect for public aquaria should be avoided, as a knowledge of the desiderata on their part too often results in the dredger being taken clear of all the productive grounds. A boat provided with a mast and sail, which can be taken down and stowed away during the dredging operations, is preferable to one provided with oars only.

A few words, in conclusion, upon the preservation of the specimens when taken from the dredge.

Echinoderms, especially Brittle-stars, should be killed by immersion in fresh water, but many species may be kept alive and their habits profitably studied, by putting them into glass bottles of various sizes, of which a good supply should be taken in the boat. Small bottles may be carried very conveniently in pockets made of some strong material, and divided into compartments like a sportsman's cartridge belt. Such pockets may be fastened by means of buttons inside the coat. I have found this contrivance more convenient than filling my coat and waistcoat pockets with bottles. The larger forms of crustacea and mollusca may be put into a small basket. For the safe preservation and carriage of large specimens, I have found a strong box, into which a large, wide-mouthed glass jar fits loosely, a very convenient arrangement. My box opens at the top, and the lid is secured by screws.

Into the jar, around which it is advisable to put a sheet of cotton wadding to protect it from injury, I generally put about a quart of the best methylated spirit, and in this the specimens may be kept for some time, but the sooner they are separated the better. Small and fragile specimens are best kept in small bottles, but not more than two or three should be put into one bottle. All specimens intended for microscopical work should be preserved in absolute alcohol, as by far the best results are obtained from its use. A one or two per cent. solution of potassium bichromate is also useful. Glycerine has been highly recommended for univalve molluscs, when the odontophores only are required.

THE ELEMENTS OF MICROSCOPY.

By George E. Davis, F.R.M.S.*

II.

Some of the properties of plates, prisms and lenses.

IN my last paper I pointed out to you some of the defects of the human eye, and showed how microscopical vision was affected by them. Your attention was also called to the fact that objects though seen plainly at certain definite distances, become indistinct and finally invisible by continued approach to the eye. The cause of this was also mentioned,—the rays proceeding from the object diverged too strongly, and thus the posterior focus is thrown behind the retina. A convex lens, if now introduced between the object and the eye, will render the object clearly visible, for the simple reason that the rays are more restored towards parallelism by means of the lens, and so form a posterior focus short enough to enable the picture to be thrown upon the retina. But, although the object previously invisible is now brought into view, yet it will appear larger than it really is, as the image presents itself to our visual organs under a larger visual angle.

This brings me to the first point of interest in connection with practical optics, that is to say, with the subject of refraction. Without the phenomenon of refraction glass lenses would be of but little service to us as magnifiers, and we should have to fall back upon reflectors as Amici did in the earlier years of the present century; and although refraction is a very useful property in

* A paper read before the Manchester Microscopical Society. The diagrams to which references will be found were shown as Lantern Transparencies. We regret that owing to their number they cannot be introduced into the text.—Ed.

materials from which lenses are made, yet it introduces many complications, which, affecting as they do the manipulation of the microscope, should be clearly understood by every working microscopist.

It has often been said in this science, as with many other things, that theory and practice will not always row together; but I wish to remark that, where practice does not conform to science, it will be found on searching deeper into our subject, that we have forgotten some necessary quantity, or have been ignorant of some hidden theory, essential to completely explain apparently contradictory results.

In speaking to you of refraction, we must put it in its simplest form, which is when the medium traversed by a ray of light is furnished with parallel sides, such as we shall meet with daily as the 3 by 1 glass slip, or an ordinary thin glass cover.

Mr. Blackburn, in his paper on "The Theory of Aperture," put before you very clearly what is meant by refraction. Every medium into which a ray of light can enter has an effect upon it, causing it to bend from the straight line, various substances deflect the ray more or less; but it will be found that in the same media the angles of incidence and the angles of refraction when compared by their sines, always exhibit a constant ratio. The more perpendicularly the ray strikes the medium, the less is its actual deflection; the more obliquely, the greater the amount scattered by reflection.

Now different media exert a more or less greater influence upon the luminous ray, and in order to show you this I have prepared a diagram, illustrating how a ray of the same obliquity in air, impinging upon layers of glass, water and glycerine is variously deflected. I wish you to bear in mind that the air ray in each case is the same, and the various angles in the denser media,—all and each correspond to the obliquity of the impinging air-ray. This is a very important fact, and I shall have to refer to it again by-and-by; but you will remember that Mr. Blackburn told us more than this, he showed in a very clear manner that the sines of the angles of refraction, and those of the angles of incidence, always possessed a certain ratio to each other, so that we can always predict what course a ray of any obliquity will take.

I have illustrated this subject by taking a ray of such obliquity as will just pass through a glass plate with parallel sides. If we increase the obliquity of the ray it will, to a certain extent, still enter the glass, but when the inside angle has reached 42° the ray will not pass out of the upper surface, but will be totally reflected from that surface downward. I wish you to remark that this total reflection takes place *in the denser medium*—from the rarer medium to the denser, such as from air into glass a portion of the rays of

any obliquity will pass; but this is not so when the oblique ray is *in* the denser medium.

This has a very important bearing upon microscopical illumination, and I wish you to thoroughly understand it, as many really good microscopists have stumbled over this question. It has a greater bearing upon the manipulation of objectives than at first thought we would imagine.

Before leaving the subject of refraction, I would like to show you one effect of cover glasses upon oblique rays of light, and one which should be well studied by all workers with dry objectives of wide aperture. I must first call your attention to what I have already said repecting total reflection. Now, all rays less than the critical angle, I have told you, will pass through the cover glass and emerge into air at the surface; rays of greater obliquity will be totally reflected. Now, if we produce these air rays backwards we shall perceive the object apparently lying in different planes,—the more central the ray the deeper will be the focus, while as the ray becomes more oblique the object apparently lies nearer the surface, until at last as we approach infinitely near 180° it appears to be coincident with the surface of the glass. This is a very important point in connection with the correction of objectives, and one which I shall enter upon in my third paper.

Thus far we have only considered the passage of light through media with parallel faces, such as the ordinary microscopical slides, or thin-glass covers; let us now examine its passage through media not furnished with parallel faces, but which are inclined to each other. That form which will interest us most is the prism—not only is this form *per se* much used in optical experiments, but it may be considered as part of a rudimentary lens. A ray of white light upon passing through a prism of glass becomes split up into several colours—red, orange, yellow, green, blue, indigo, and violet; or, as some prefer to say, *red*, *yellow*, and *violet*, and their mixtures. Now, this elongated coloured band is called a spectrum, and it may interest you to know that the relative size and quality of the band depends to a great extent upon the nature of the medium through which it passes, upon the quality of the light and upon the angles of the prism. The red ray is the least disturbed from its position; or, I may say, the rectilinear path, and the violet most; this disturbance being the general rule.

I have told you that the nature of the light establishes generally the character of the spectrum, and in proof thereof the different spectra produced from several sources of flame may be well studied. In the ordinary solar spectrum, from the dark-red to the violet, you will see also a number of dark lines running vertically, which are technically termed Fraunhöper's lines. The seven spectra which you see below that of the solar spectrum, are those

of solar prominences, and very different to that of ordinary daylight. You will notice they are reversed—dark, with bright lines, and that all the bright lines correspond in position to the dark lines of the solar spectrum.

The next diagram will show you the spectrum produced when the rays from a fixed star are passed through a prism of glass. There is the coloured spectrum, containing dark lines too, but they take different positions to those I have shown you in the solar spectrum.

So is it also with other stars, the spectrum of Aldebaran, a star of the first magnitude in the eye of the constellation Taurus, is now before you, with Orionis also. There is the coloured band, and many dark lines which occupy the same relative positions as many of the solar lines.

It is not my intention to treat of the nature of these lines, but my reason for introducing the subject is to explain that, though they vary with different sources of light; that taking the solar spectrum these lines occupy constant positions, *cæteris paribus*, and the most prominent of them are used in optical work to identify some particular portion of the spectrum, or some of the effects on a ray of light by its passage through different prisms.

We may now see upon the screen a much enlarged figure of the solar spectrum; the A line is in the extreme red, B in the light red, C in the orange, D in the yellow, E in the green, F in the blue, G in the indigo, and H in the violet.

The relative separation of these lines from each other is called the dispersion of the ray, and it should be carefully studied, as it has an important bearing upon the construction of lenses, and also upon the manipulation of immersion objectives.

If we take two prisms, the one of crown glass and the other of flint, we shall find that if they both possess the same refracting angle, say 60°, the flint prism will deflect the violet rays to the greatest extent, and if we alter the refracting angle of the flint to 52° we shall get spectra, in which the D line is equally refracted in both cases; but the flint, even then, gives a spectrum of nearly double the length of that yielded by the crown glass, and if we wish to obtain a band of colour of equal length with that produced by a crown prism of 60°, we shall have to make the flint with 30° refracting angle. This will bring the B lines and the H lines nearly coincident, but a closer inspection will show us that the intermediate lines do not coincide,—a fact of vital importance to the practical optician.

A flint prism of 30° will thus correct the dispersion of a crown prism of 60°, that is to say, there will be no colouration of the ray, but it will be deflected from its rectilinear path, as you will see in the diagram.

The crown prism C produces the deflection shown by the red and blue lines, and this dispersion is restored by the flint prism of smaller angle F.

It will thus be seen that many modifications are possible, by combining flint and crown prisms of different angles, an instance being found in the direct vision spectroscope of which I have one here for your inspection.

The direct vision spectroscope is often used in conjunction with the microscope, and is more often called a micro-spectroscope. In this instrument the ray is much dispersed but not deflected, this being effected by turning the base of a flint prism towards the apex of one of crown glass, cementing them together with Canada Balsam. They are usually joined in combinations of three or five, one flint between two crowns, or two flints alternately with three crowns.

So much, then, for the effect of a triangular piece of glass upon a bundle of rays of white light; we must now consider the effect of a lens which may be shown to consist of little else than two prisms turned base to base, as you will see by the diagram.

The top half, and also the lower half of the lens, each acting as a real prism, and the violet rays being the most refrangible, come to a focus nearer the lens than the red-rays. This effect is known as chromatic aberration, and has to be eliminated in the process of objective construction. I shall have to refer to this diagram again in connection with the construction of lenses for photo-micrography, but I wish you all to see how these apparently small points are mixed up with microscopical manipulation.

I showed you in my last paper that a picture might be obtained upon a screen without the aid of a lens in somewhat a similar manner to the diagram now shown, and you will no doubt expect that such a picture would be free from the defects produced by chromatic aberration. This is so, but such a picture is by no means perfect; there are many objections to the use of such a method, and so we are bound to fall back upon lenses of glass as the most convenient means of magnification.

But lenses of glass, besides being afflicted with errors of chromatism, are likewise affected by the tendency of the peripheral rays to focus themselves at a point between that taken by the central ones and the lens itself. The diagram will show this error, which is called spherical aberration.

You will be able by this diagram to see how easy it is, comparatively speaking, to construct the very cheap microscopes one sees sometimes, for by cutting down the aperture, that is, by stopping out the majority of the peripheral rays, leaving only, say, what is represented by the three central ones, a very fair focal point is obtained.

I will now show you another diagram, illustrating chromatic aberration, from which it will be seen how curiously the various rays intersect each other :—

It is a difficult thing to entirely separate chromatic aberration from spherical errors, in order to study it by itself, but it may be done by using mono-chromatic light.

We may now see a dawning of the processes used for achromatizing lenses. Certain combinations of crown and flint are put together, in order that there may be no colour in the image produced by them, and it may be inferred from what has been previously shown, that very diverse effects may be produced by altering the various curves of the component flint and crown lenses, and their relative thicknesses.

The top figure of the diagram shows a prism in which a ray of white light has been decomposed by the crown prism C, and amalgamated again by the small flint prism F, and the application of this principle to the construction of objectives is shown in the side figure, where a concavo-convex of flint is cemented to a double convex of crown.

A lens in its natural state is very much under-corrected; the violet rays, as I have already shown you, are brought to a focus between the lens and the fôcal point of the red rays—now, it is possible to reverse this order of things, and by applying a flint concave of sufficient strength, to bring the red rays to a focus at a point intermediate between the lens and the focal point of the violet. Such a lens is called over-corrected, and is shown diagrammatically by the figure on the screen. This was the condition in which all the older lenses were turned out, as it was thought necessary to do so in order to correct the aberrations of the Huyghenian eye-piece.

I now come to a point which will no doubt interest you all, viz.,—the true explanation of what is meant by the focus of a lens. You will doubtless know that parallel rays, such as those of the sun, falling upon a double convex lens of crown glass, bring those rays to a focus substantially at the radius of the curvature of that lens; but if the lens is plano-convex, the rays will focus themselves at the *diameter* of curvature.

Now, the sidereal focus of a lens, or the focus of the sun's rays, is always shorter than those obtained in the microscope. If we shorten the posterior focus we gradually lengthen the anterior focus, so that when the rays, falling on a double convex lens from a distance of the diameter of its curvature, are brought to a focus, they fall at the same distance on the opposite side of the lens.

The nearer the source of light to the centre of curvature, the more parallel will the outer rays become; the longer the anterior focus, the shorter the posterior.

The following diagrams will perhaps explain this,—

When working with non-achromatic plano-convex lenses,—such as the bull's-eye condenser, for instance,—it should not be overlooked that the spherical aberration is always less when divergent or parallel rays fall upon the curved side of the lens.

We may now be able to comprehend why the term sidereal focus, or, simply, focus, has been adhered to so long: parallel rays falling upon lenses of varying curvatures yield foci at definite distances from the lenses, and we shall now see that the magnifying power of a lens depends upon the curvatures of its surfaces. A plano-convex lens, ground to a curve of half-an-inch radius, would give us a one-inch lens, magnifying ten diameters, while a double convex lens, ground to the same curves, would be a half-inch lens, magnifying twenty diameters; not, be it understood, that these lenses would focus at one inch, or half-an-inch respectively from the object, but, that when solar rays are transmitted through them, the focal point is situated at those distances from the outside surface, as shown upon the screen.

Last to be considered is working distance, and from the diagram you will be able to see that the thickness of the lens must affect this very materially. If the thickness of the lens before you be a quarter of an inch, the working distance will be a trifle over three quarters of an inch. The thickness of a lens does not alter its magnifying power.

Having, then, for our guide the fact that the working distance of a plano-convex lens, with its plane side to the object, is that of its sidereal focus, less the thickness of the lens, and plus a small quantity due to the reduction of the posterior focus from infinity to about ten inches, we shall see that if the lens is a hemisphere the working distance will be approximately half its focal length. This is true for single lenses only, as the back combinations of an objective require the approach of the front lens to the object much nearer than the above rule would indicate.

My paper having now exceeded the bounds at first planned for it, I will conclude for the present, and if you desire to hear more I shall feel happy in giving you another paper "On the Construction and Use of Objectives," in which I will deal with the aperture question.

PREPARING ILLUSTRATIONS OF MICROSCOPICAL OBJECTS.

IN our last number, upon page 19, we endeavoured to show how good illustrations of microscopical objects might be produced as blocks by the process of photo-zincography. We did not of course intend to convey the idea that such blocks would equal the best copperplate engravings, or indeed surpass the very excellent wood-cuts which have appeared from time to time illustrating microscopical subjects, but we do intend our readers to understand that these blocks, being facsimilies of the microscopist's own drawings, are more likely to be truthful representations of nature than those made by artists who never have seen the organ or organism in question, who do not understand either its formation or its functions, but touch up the rough sketches with which they are supplied, in order to produce a good picture from an artistic point of view.

No one but those actually acquainted with such work as this, can form any estimate of the difficulties which stand in the way of obtaining truthful pictures of the subject when once the limner has been called in to exercise his ingenuity upon it. It was once the fashion, but, alas! nearly extinct, for the investigator to employ his own artist, who, working under his own supervision, produced drawing after drawing, until, finally, the patient investigator was satisfied that the illustration was really a faithful representation of what he had seen upon the stage.

We cannot all of us keep artists to daily or even hourly record what we see under the microscope, but most microscopists can readily learn to draw from nature what they have observed. The camera lucida will help them, by enabling them to easily reproduce the outlines, while the details can be afterwards put in by the eye alone.

If, however, the observer is not able to draw even a fair picture of an object, photo-micrography is still open to him; a photograph can be taken and transferred to wood, this serving the engraver as a guide almost as well as the more elaborately finished pencil sketch, provided he be somewhat acquainted with his subject.

There is a danger in this method of procedure which it is the object of this paper to point out. The illustrations, Figs. 20 and 21, are amongst our experiences in this matter, and it would be well for us to go into details, in order that those who require illustrations may not be led into similar pitfalls.

Fig. 20 was produced from a photograph, taken by ourselves, to illustrate Mr. Rideout's paper upon *Dytiscus marginalis* for our

first volume. It was near Whit-week, and wishing to avoid disappointment, sent the photograph to London to be engraved. With the result we were not pleased, and therefore sent another copy of the photograph to a local engraver, who produced cut Fig. 21. Neither of these are absolutely correct, as our readers will see;

Fig. 20.

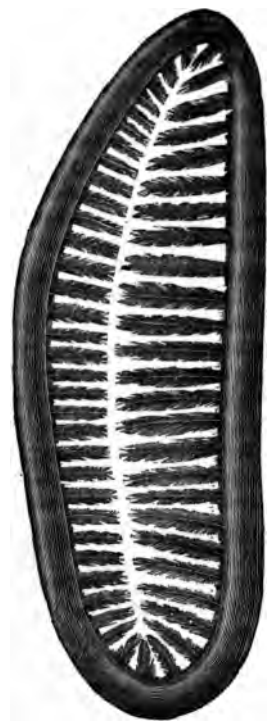

Fig. 21.

there has been too much touching up done, and the picture is more artistic than real, while in Fig. 20 the engraver has not caught the idea from the photograph; the illustration appears to represent more nearly a white feather lying upon a black ground than an opening surrounded by small featherets, which the engraver has exaggerated in Fig. 21. We hope in a short time to give another

illustration of this object, the spiracle of the *Dytiscus marginalis*, which will more nearly represent the organ in its natural state, as another illustration of the usefulness of photo-zincography.

NOTES AND QUERIES.

MICROSCOPICAL MOUNTING.—At the January meeting of the instruction class of the Manchester Microscopical Society the demonstrators showed the nature of Balsam and Benzol as a mounting medium. Mr. Mestayer cut a number of wood sections, both transverse and longitudinal, of the Pine, Walnut, and Mahogany, giving a few hints as to the method of mounting. He also mentioned the carrot as a simple and satisfactory bedding material for many substances.

HERTFORDSHIRE NATURAL HISTORY SOCIETY.—We have just received the August and November Transactions of this Club. In the former appears a very interesting paper "On Methods of Prevention of Insect Injury," by Eleanor A. Ormerod, F.M.S., which should be read by all agriculturists; it is continued in the November number on page 80. In this latter number also there is an account of a new flagellate animalcule, *Chlorodesmos hispida*, illustrated with a well-executed plate.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the last meeting of this Society the Annual Report was read, briefly enumerating the various discoveries made by the members during the past year and the various localities recorded for rare species.

The Hon. Sec. made some observations on specimens of *Pottia cavifolia*, which had been sent from Llandudno, and he also exhibited specimens of *P. canina* from the Continent, which Dr. Wood thought possibly might be found to occur in Britain, if sufficient attention was paid to the genus.

The interesting continental *Phasomitrium subsessile* was exhibited. The specimen had been gathered by Prof. Schimper in Styria. It was a well-marked species and typical of a distinct subdivision of the genus Pottia. It is, however, not yet known as a British Moss.

Mr Atkinson exhibited specimens of *Peziza aurantia*, which he had seen growing in large beds near Bowness, in Sept. last.

After the election of officers the meeting was brought to a close.

ILLUMINATION OF SEMI-OPAQUE OBJECTS.—As the method of mounting insect preparations without pressure is becoming general, reference to the illumination of such objects on microscopical examination of them may be useful. It is obvious that objects so mounted must necessarily vary in their transparency, parts of them being more or less opaque; but much benefit, it has been observed, may be found from the use of the condensing lens above the object, at the same time throwing the light up from the reflecting mirror below. A specimen of the *Cimex* mounted in balsam by the carbolic process affords a good exemplification of such double illumination.—A. M. M. J.

[Carbolic acid liquified by the addition of a few drops of water has long been used in this country for mounting insects without pressure. We were shown specimens of *Cimex lectularius* mounted in this manner at the Chester Soiree of 1880.—ED.]

EXCHANGE DIATOMS.—Fossil diatoms from Bohemia and Hanover in exchange for micro-material, mounted or unmounted. T. C. Rinnböck, 14, Simmering, near Vienna, Austria.

MICROSCOPICAL SECTION.—At a joint meeting of the Manchester Literary and Philosophical Society and the Microscopical and Natural History Section of the Society, held on the 12th December, Mr. John Boyd exhibited a fine living specimen of *Argulus foliaceus*, a parasite of the carp.

Mr. Charles Bailey, F.L.S., made some remarks on the occurrence of *Selinum carvifolia* in Lincolnshire, and of *Potamogeton zizii* in Lancashire and Westmoreland, and mentioned the localities where he had met with them respectively.

Mr. R. D. Darbishire. B.A., F.G.S., gave an account of dredgings made by him in company with Dr. A. Milnes Marshall and Mr. Archer, at Oban, in Sept. last, and exhibited specimens of a considerable variety of animals taken.

Professor A. M. Marshall gave a detailed description of three forms of Pennatulida met with during the dredging, and suggested the desirability of the section undertaking or taking part in similar excursions in future years.

LANTERN TRANSPARENCIES.—A growing want has for some time been felt by lecturers on biological subjects, and especially by those whose lot it is to address large audiences or classes, of a good series of lantern slides, which would do for biology what has been so well done for physical science by York's series of slides. The ever-increasing use of the oxyhydrogen lantern as a means of illustration, especially with popular audiences, renders this need more apparent. Arrangements have, however, now been made with Messrs. York

and Son, 87, Lancaster Road, Notting Hill, London, W., to issue such a series, under the supervision of Dr. Andrew Wilson and of Mr. Wm. Lant Carpenter, to whom, at 36, Craven Park, Harlesden, London, N.W., or to Dr. Wilson, 110, Gilmore Place, Edinburgh, any communications on the subject may be addressed. It is intended that, in the first instance, the series shall comprise some of the principal types and life-histories of the lower forms of plant and animal life, and the elementary facts of animal and vegetable physiology. It is believed that the knowledge that these are in preparation, may save the construction of diagrams by some lecturers, and may lead others to make valuable suggestions as to sources of illustration, &c., to one of the above-named gentlemen. —*Nature.*

ELECTRIC ILLUMINATION FOR THE MICROSCOPE.—Messrs. Mawson and Swan are now selling small lamps for the illumination of Microscopic Objects in place of oil or gas. It is claimed for this new form of illumination, that the trouble in cleaning and preparing the oil lamp, and the unpleasant heat and smell given off by it, is in this Lamp entirely avoided; that the light is of purer quality; that the great ease and facility with which this Lamp can be adjusted is beyond comparison with the ordinary oil or gas lamp, especially when it is required to change the position of the light to above or below the stage, as for opaque or transparent objects; and that condensers may to a great extent be dispensed with, thus also saving much trouble.

The Lamp is calculated to give from 1 to 3 candle power, and is readily controlled by means of a small resistance coil of iron wire interposed in the circuit. The best form of battery is undoubtedly the Grove or Bunsen, three cells being generally sufficient.

In a circular which the above firm have issued, it would appear that the origination of this idea was due to a Mr. Stearn, of Liverpool, but if they reflect, they will doubtless come to the conclusion, that if they had executed the order given to them in 1881, Mr. Stearn (who was associated with Mr. Swan in the production of the ordinary lamp) would probably have been second or third in the field. Perhaps the publishing of the correspondence would be an aid to memory.

Messrs. Mawson and Swan claim that this method of illumination saves the trouble of cleaning and preparing the oil lamp: for our own part, we would prefer to have this trouble rather than the overpowering fumes from three cells of a Grove's or Bunsen battery. The electric light for microscopic purposes is no doubt in some instances a good thing, but its conveniences need not be exaggerated.

CUTTRISS' DYNAMO.—Messrs. T. and S. W. Cuttriss, of 83, New

Briggate, Leeds, are now producing small dynamo-electric machines, ranging from £5 10s., upwards. One of our correspondents informs us that one of these machines of lowest price will just keep in good order one 20 candle power Swan incandescent lamp.

STAINING NUCLEI.—At a meeting of the Société Belge de Microscopie, M. Errera stated that the anilin color nigrosine was an excellent reagent for staining nuclei. He showed some sections of vegetable tissues, colored with this substance, in which the nuclei had taken a very pronounced blue coloration, which admirably revealed the details of their structure, while the rest of the cell remained unstained. The sections to be stained are allowed to remain in the aqueous solution of nigrosine for a short time, and are then washed in water until the liquid extracts no more color. They may then be mounted in glycerin, or else passed through alcohol and mounted in balsam or dammar in the usual way.—*A. M. M. J.*

A NEW PATHOGENOUS BACCILLUS.—Prof. C. J. Eberth recently found a new form of *Bacillus* in a badger's liver. They occurred in the pus-corpuscles in small abcesses, which they appeared to have caused by penetrating through the capillary tubes, and producing necrosis of the hepatic tissue. Some were also found in other organs. These *Bacilli* have the form of cylindrical rods, occasionally consisting of two segments. Staining with iodine solution or Bismarck brown shows the presence, in some cases, of dark brown granules of uncertain nature. The specimens were obtained by placing thin sections of the liver in a solution of methyl violet, then leaving them in water acidulated with acetic acid till no more colouring matter was removed. After passing through alcohol and clarifying with oil of cloves, the sections were mounted in balsam. In this way only the nuclei of the liver cells, the pus-corpuscles, and the *Bacilli* were stained.

VOLVOX MINOR.—According to Kirchner, the following is the mode of germination of the oospores of *Volvox minor*. In February the endospore swells up, while from the ruptured exospore issue the contents of the oospore in the form of a sphere, which subsequently separates into four cells connected with each other at the posterior end. A new family springs thus from each oospore. It is also found that *Volvox minor* is not diæcious but proterogynous, the families passing first through a female and then through a male condition.

ERRATUM.—On page 17, line 7, for "B or even higher ocular"

read E or even higher ocular. Will readers kindly make this correction in the margin?

CELL DIVISION.—Some very interesting information on this subject is due to Prof. Strasburger. He recommends the hairs in the filaments of *Tradescantia Virginica* or *T. elata* for studying the various phenomena, as, among other advantages, the hairs retain their vitality for as long as twelve hours in a one per cent. solution of cane sugar. The division generally takes place in the terminal cell of the hair, or in the cell next to it. The nucleus, about 0.018 m.m. in diameter, has the appearance of a reticulated structure, sometimes, though very rarely, containing large granules resembling nucleoli in form. When about to divide the nucleus increases in size, especially in length, and then protoplasm begins to collect at both its poles. The body now becomes coarsely granular, and the granules gradually collect into lines permeating the nucleus more or less obliquely and with somewhat of an S-like curvature. All this has occupied from three to four hours. Next, these lines begin to disappear, and after one or two other changes in its appearance, the nucleus takes the form of a barrel which shortly separates into two halves, the rupture occurring at the equator. A colourless hyaline substance may be noticed between the two halves, which, when treated with absolute alcohol or one per cent. chromic acid, shews very beautiful striations. Soon, a number of dark granules, which were about the equator of the barrel, coalesce and form a pellicle constituting the new cellulose wall. In three quarters of an hour from their separation, the two new nuclei have assumed their permanent character. To observe these phenomena a drop of one per cent. solution of sugar is placed on the cover glass, in which, when spread out, the freshly gathered stamen is immersed. The cover-glass is then turned over and placed with its edges on a papier-maché frame.

THE VINEGAR PLANT, AND SIMILAR FUNGI.—*Mycoderma aceti*, the vinegar plant, has been observed by Schnetzler to undergo a curious development in white wine—whether exposed to the air or otherwise. A number of cup-shaped masses were produced, which, falling in succession to the bottom of the bottle, formed a cylinder four inches in length. Each cup in falling left behind it a train of bacterial matter, enveloped by gelatinous material agreeing in chemical characters with the cellulose of most Fungi. As this *Mycoderma* absorbs tannin in quantity, it is probable that the colour of the vinegar is due to the presence of this body, derived from wine in the presence of an iron salt. *Mycoderma vini*, the fungus produced in wine in presence of air, is composed of cells from 2μ to 3μ in diameter, reproduced by gemmation, and sometimes by

ascospores. This fungus gives rise to an alcoholic fermentation, as may be proved by keeping it for a time in pure grape juice. This fermentation, however, is checked by the presence of borax. The phenomenon known as ropiness in wine seems to be due to immense numbers of bacteria in strings. This is more often the case with white than red wines, owing, according to Francois and Pasteur, to the greater amount of tannin to be found in the latter. *Mucor racemosus* has also been found in ropy wine.

FUNGUS PESTS OF THE POTATO.—According to Reinke and Berthold, the moist decay of the potato tubers is owing to two bacteria, *Bacillus subtilis* Cohn, and a new form which they name *Bacterium navicula*, the presence of *Phytophthora* being a predisposing cause. Other saprophytic fungi promote the decay. The crinkling of the leaves of the potato is referred to a fungus which they name *Verticillium alboatrum*. The above-mentioned authors treat also of the history of development of some of the more important of these pests.

COLLECTING MARINE DIATOMACEÆ.—The following method is recommended by Mr. K. M. Cunningham as giving especially abundant supplies of *Pleurosigma* and *Coscinodiscus*. The back of each one of a peck of fresh oyster shells is brushed into a basin of water. In this product some tufts of cotton wool are immersed, so that the mass will take fire and burn at a red heat. A still stronger heat, however, must be applied to destroy the animal particles of the oyster, which will inevitably have found their way into the basin.

MICROCOCCUS PRODIGIOSUS.—The growth of this blood-red protophyte on its best substratum—slices of cold boiled potato—is found to be altogether checked by the passage of a strong electric current, the germs being killed. This organism attacks wheat-meal and rice under any circumstances, but eggs, turnips, or potatoes, are not infected unless boiled. A wadding stopper effectually prevents the passage of the germs. Water is unfavourable to its growth, and alcohol, nitric, and carbolic acids speedily kill it. It can exist for a few days in glycerine, and appears to thrive in dilute salicylic acid.

PREPARING SECTIONS OF SPONGES.—The following is Mr. Sollas' method:—A good representative piece of the sponge is well soaked in distilled water to remove its contained alcohol. After this, it is placed for an hour in a strong solution of gum, and then transferred to the well of a freezing microtome. Sections of any required thinness can now be cut in the usual way, the razor

passing with apparently equal facility through the soft tissues and the hard spicules. Some of these slices—stained and unstained—Mr. Sollas mounted in glycerine, others in Canada balsam, after successive treatment with absolute alcohol and carbolic acid and turpentine. Before preserving sponges in spirit, he recommends a preliminary soaking in a .02 or .03 per cent. solution of osmic acid, as the histological characters of the specimens are thus less injured.

THE INDIGO CARMINE SOLUTION of Tiersch is a good and useful blue stain for sections of brain and spinal cord after they have been hardened in chromic acid; it possesses one convenient quality—viz., that if the sections are too deeply stained, any excess of colour may be removed by the action of a saturated solution of oxalic acid in alcohol. This reducing process should be used with caution. Tiersch's fluid consists of:—Oxalic acid, 1 part; distilled water, 22 to 30 parts; indigo carmine, as much as the solution will take up. A further dilution with alcohol may be necessary; the sections should be immersed in it from 12 to 48 hours; the colour will determine the time.—*Hogg.*

BORAX CARMINE.—(1) carmine, ½dr.; (2) borax, 2dr.; (3) distilled water, 4oz. Rub 1 and 2 together in a mortar and gradually add the water; let them stand in a warm place for 24 hours, after which pour off the supernatant fluid, and the solution is ready for use.—*Hogg.*

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 27. *MARCH.* 1883.

NOTES ON MOSSES.

BY WILLIAM STANLEY.

(Continued from page 39.)

ALLIED to Gymnostomum on the one hand, and to Dicranum on the other is the genus *Weissia*, named in honour of Weiss, a cryptogamic botanist of Gottingen.

It has erect, oblong-ovate capsules on a long straight fruitstalk; lid with an inclined beak and annulus persistent; peristome of sixteen linear-lanceolate teeth, equi-distant, without a medial line, entire or perforate and sometimes bifid at the apex. Leaves octofarious, curved and crisped when dry, lanceolate or linear-lanceolate; nerved, and of close texture.

The plants are cæspitose, and perennial with forked branches (dichotomous), and are generally found on soil. *Weissia controversa*, the green-tufted Weissia, is frequent on banks, &c., and is distinguished from *W. cirrhata* by the involute margins of the leaves; the stems are $\frac{1}{8}$ to $\frac{1}{4}$ inch in height, more or less branched with lower leaves lanceolate, and upper leaves linear-lanceolate; nerve slightly excurrent; capsule oval, lid conical, with a rostrate beak; annulus narrow. Inflorescence monoicous and barren flowers gemmiform. (Fig. 22.)

As is generally the case with Mosses and other plants widely distributed, this species presents a good deal of variation of form.

Also, monoicous, although not so frequent, are *W. mucranata*, the point-leaved Weissia, and *W. cirrhata*, the bent-leaved Weissia. The first is rather smaller than *W. controversa*, and has oblong capsules; the leaves have plain margins, with nerve excurrent into a slight mucro. It is found on fallow clay ground. *W. cirrhata* is found on posts and rails, also on rocks in mountainous districts, and is known by the reflexed entire margins of the leaves. The pale brown capsule has the teeth of the peristome inserted considerably below the contracted mouth, and varies in shape from

shortly oval when found on posts, to almost cylindrical when on rocks; lid with a long beak. Stems ½ to 1 in. high, loosely tufted; leaves linear-lanceolate, spreading, concave and not nerved to apex.

W. calcarea and *W. commutata* are placed amongst excluded species in the London Catalogue, although given in Hobkirk's Synopsis along with *W. truncicola.*

Gymnostomum tortile, the curly-leaved, beardless Moss may be found on limestone rocks in Derbyshire, and on chalk cliffs in Sussex. It is a densely tufted Moss, with crowded leaves strongly nerved, curved in the upper part, and incurved and crisped when dry; obtuse at apex and apiculate; capsule elliptical; lid rostrate; monoicous.

Many of the Earth-Mosses ripen their spores in the spring, and

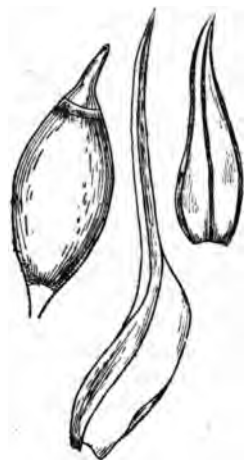

Fig. 22.

of those fruiting *P. cuspidatum* is a very variable and common Moss on moist banks and hedges and in fields. It is from ⅛ to ¼ inch in height, with ovate-lanceolate, cuspidate leaves, with the nerve prominently excurrent; capsules roundish, immersed, on a short pedicel.

P. bryoides, the tall Earth-Moss, is rare.

Another species, common on banks and in fields, is *Pleuridium subulatum*, the awl-leaved Earth-Moss. Stems ⅛ in. high; leaves lanceolate, sharply tapering from a broadish base, with a broad nerve ceasing near the apex; capsules roundish, ovoid and pale brown, immersed, on a very short pedicel.

Not so common as the last, and distinguished from it by its more

rigid leaves, is *P. alternifolium*, the long-leaved Earth-Moss. The leaves are also more dilated at the base, and have a thicker, broader nerve; capsule ovoid, immersed, brownish, with an oblique point.

Sphærangium triquetrium, the triangular dwarf Earth-Moss, is a very rare Moss, found only on the Suffolk coast. Also, rare, are *Systegium crispum*, *S. multicapsulare*, and *S. Mittenii*.

Archidium phascoides, the large-seeded Clay-Moss, is separated from the Phascums by its sessile globular capsule, large spores and perennial growth, and is the only species found in Europe.

It is named from αρχιδιον, beginning, because it is the first and most simple of the series.

It frequents moist banks, heaths, and fallow ground, in a clayey or chalky soil; its stems of the first year being $\frac{1}{4}$ in. long and simple, while the following year they are almost 1 in. long, decumbent, branched and elongated, with lanceolate distant leaves.

Brachyodus trichodes, bristle-leaved, is a very small and slender Moss, with leaves almost setaceous. The teeth of the peristome are very short, with a large annulus, and it is the only species of this genus. On sub-alpine rocks, chiefly of granite or sandstone.

Without peristome, though possessing a deciduous lid, is the genus *Pottia*, belonging to the family *Pottiaceæ*, as are the preceding *Phascums*.

It is named in commemoration of Professor Pott, of Brunswick, and consists of annual or biennial plants, mostly found on newly exposed soil, though occasionally on walls in lowland districts. The leaves are in five series $\frac{2}{5}$, semi-amplexicaul and spreading, ovate-oblong or obovate-lanceolate, with loose quadrate or rectangular cells, the lower ones enlarged.

The excurrent nerve forming a short narrow point or *arista*. Capsule roundish or oval; lid with an oblique beak. Inflorescence Monoicous.

The next common, and also the typical species of this genus is *Pottia truncata*, the blunt-fruited Pottia. It is found on newly exposed soil in fallows, on banks in gardens, &c. The stems are from $\frac{1}{2}$ line to $\frac{1}{2}$ in. long, with leaves widely lanceolate, often wider above the middle, acuminate, the margin reflexed, nerve slightly excurrent; capsule truncate, obovate and wide-mouthed; lid with a long oblique beak. (Fig. 23.) Not so frequent as the last, and with a different habit, being found on banks and mud walls, is *P. cavifolia*, the oval-leaved Pottia. Wilson remarks, that this is a species which varies remarkably, even in the same locality, in the length of the leaves, fruitstalk and capsule; the different forms growing not promiscuously, but in separate groups; some with fruitstalks above $\frac{1}{2}$ in. long, others scarcely a line in length, and the leaves equally variable, so that an observer is not easily persuaded to consider them to belong to one species.

It may always be known by the concave leaves bearing on the upper side three or four membranous appendages attached to the nerve; generally the leaves are obovate or elliptical, erecto-patent, and slightly imbricated; capsule oval on a short pedicel, lid with an oblique beak shorter than the capsule.

A very small species, fruiting both winter and spring, is *P. minitula*, the dwarf Pottia. Rather rare are *P. Wilsoni*, the oval-fruited Pottia and *P. crinita*, the bristly Pottia; while very rare are *P. viridifolia*, *P. littoralis*, and *P. asperula*. *P. Heimii*, the lanced-leaved Pottia is very distinctly separated from the rest of the species by its polygamous inflorescence and by the spreading, oblong, lanceolate leaves, which are denticulate, or serrate at the apex;

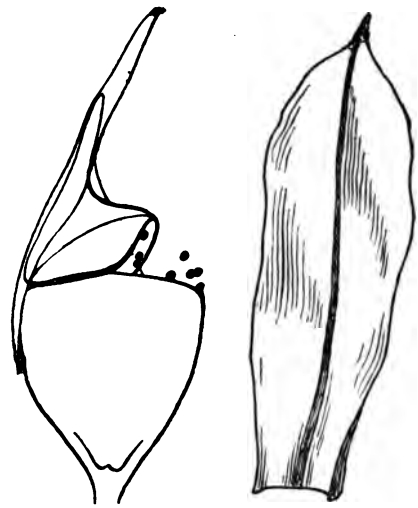

Fig. 23.

nerve ceasing at or below the point; capsule obovate or oblong, not contracted at the mouth, the lid adhering to the columella some time after maturity.

Growing on moist banks near the sea, it does not ripen its fruit until April or May.

Agreeing in habit, mode of growth and fruiting, but differing from Pottia by the presence of a single peristome of sixteen teeth is the genus Anacalypta, represented by four species, the typical one of which may be said to be *A lanceolate*, the lance-leaved Anacalypta.

It is gathered on moist banks in calcareous soil, walls; calcareous rocks, &c., and varies in size from one line to $\frac{1}{2}$ in. long; the leaves

are ovate-lanceolate, acute, the nerve excurrent into a rather long hair point; oval capsule with a rostrate lid.

A. Starkeana, named after Mr. Stark, is recorded for the south and middle of Britain, and is very rare for Yorkshire and the Lake district. *A. cæspitosa* and *A. latifolia* are very rare.

Amongst the Tortulas or screw Mosses, there are fruiting this month three belonging to the section Cuneifoliæ, having broad, or spathulate-lanceolate leaves similar to the wall-screw Moss, *T. muralis*. *T. atrovirens*, the thick-ribbed screw Moss is found on dry banks near the sea; the leaves have revolute margins, with a thick nerve prolonged into a short mucro.

The other two are rare: *T. cuneifolia*, the wedge-leaved Tortula, found on banks on the sea coast, and *T. Vahliana*, with broader, softer leaves, and narrower capsules than *T. muralis*.

It is found on damp clayey ground by road sides, &c. *T. lamellata*, belonging to the Aloidella group, has the true peristome of a Tortula; but, according to Dr. Schimper, it is so fragile that it always falls off with the operculum.

The section Syntrichia of this family is distinguished from the other seetions by the lower portion of the peristome forming a long tube, the following species of which may be mentioned—*T. princeps* or Mulleri.

Muller's Screw Moss, growing on Scotch rocks has stems 1 to 2 inches high, with brownish radicles; leaves erecto-patent; oblong-broad, and fawn coloured, with reflexed margins; capsules cylindrical on a purplish seta; synoicous.

T. ruralis, the great hairy screw Moss, is the typical species of this group; it is found on wall tops and roofs, and is very generally distributed.

Leaves squarrose, recurved, ovate-oblong, keeled, nerve excurrent into a long hair point, rough with minute prominences *(scabrous)*; capsules sub-cylindrical; lid long; conical; dioicous.

T. intermedia is similar in character, but with erecto-patent leaves and shorter capsules, and is found growing on limestone rocks.

The fruit of *T. papillosa* is not known, but the species is very distinct from the thickly papillose back of the nerve. The fruit of *T. latifolia*, the wide-leaved screw Moss, is very rare.

Loving high moorlands is *Didymodon flexifolius*, or the bent-leaved, while Cornwall is the only recorded county for *Ditrichum subulatum*.

In the *Encalypta* or Extinguisher Mosses, the calyptra completely envelops the capsule, hence its name, and it is noticeable that in *E. vulgaris* the normal form is very rare, while the variety *β* is frequent in limestone districts on rocks and walls.

Named after Grimm, a German botanist, and easily recognized,

is the genus Grimmia, and although one or two species are sometimes found on walls and trees, it may be said to be peculiar to mountainous rocks.

The species *G. apocarpum* and *G. Doniana*, as well as *G. ovata*, fruit both in the spring and autumn.

Those of the more common species exhibit well marked differences. *Schistidium apocarpum*, the sessile-fruited Grimmia, has the capsules immersed and almost sessile at the apex of the stem; the leaves being lanceolate-acuminate from an ovate base, and the nerve ceasing below apex. *G. pulvinata*, the grey-cushioned Grimmia, has capsules drooping, ovoid, eight-furrowed, and much exserted; leaves elliptic lanceolate, terminated by the nerve excurrent with a long hair point; while in *G. Doniana* the capsule is quite smooth and slightly exserted, the erecto-patent leaves being lanceolate-elongate and tapering into a roughened hair point. Also with a rough hair point to the leaf, and the capsule more exserted than the last is *G. ovata*, the oval-fruited Grimmia. *G. confertum*, the close-tufted Grimmia, has almost sessile and smooth capsules, similar to *G. apocarpum*, the strongly-nerved ovate-lanceolate leaves having thickened margins; they are an intense green above while blackish below.

The following are not mentioned as found fruiting in Britain:—*G. anodon*, *G. crinita*, *G. subsquarrosa*, *G. robusta*, *G. contorta*, *G. elatior*, *G. Hartmanni*, *G. Ungeri*, *G. montana*, and *G. elongata*. Many of these are very rare. *G. orbicularis* is found fruiting in February on limestone rocks, and in the spring *G. commutata* on dry quartzose rocks at Clova in Scotland.

Allied to Grimmia, but consisting of taller and handsomer Mosses are the Fringe Mosses. *Rhacomitrium*. *R. fasciculare*, the green mountain Fringe Moss, grows on rocks in loose irregular patches of a light green colour, and has crowded leaves, lanceolate, from a broad base, with margins recurved, areolæ long, narrow, sinuous; capsule elliptical, with a long, subulate lid; calyptra very papillose.

R. heterostichum, the bristly mountain Fringe Moss, grows in round hoary patches: its crowded lanceolate leaves taper into a long silvery denticulate point; capsule sub-cylindrical, mouth very small; calyptra papillose at apex only.

R. languinosum, the woolly Fringe Moss, grows in extensive hoary patches, especially at a considerable elevation, with slender fragile stems, often a foot long; leaves lanceolate, spreading, tapering into an elegant toothed diaphanous point; capsules small, ovoid on a short roughish seta, owing to the irregular growth of innovations, the fruit usually appears to be lateral.

The teeth of the peristome and the lid are both nearly as long as the capsule; calyptra papillose at apex. *R. canescens*, the hoary Fringe Moss, is found on sandy heaths and stony places in

loose yellowish-green patches; stems two to four inches long; leaves ovate-lanceolate, with long white denticulate points, rough with papilla.

Fruitstalks about an inch long, with ovate capsules; lid slender and longer than capsule; calyptra slightly papillose at the apex.

It is common on rocks and walls in mountainous places. Distinguished by its plicate calyptra is *Ptychamitrium polyphyllum*, the many-leaved Fringe Moss.

The green-tufted Yoke Moss, *Zygodon viridissimus*, is found on trees and sometimes rocks, but seldom in fruit, as is generally the case in all species which have dioicous inflorescences; the fruit is of rare occurrence, and is found only where plants of both kinds of flowers grow near to each other as *Polytrichum commune*; a variety, *rupestris*, is found on rocks near Buxton, but not in fruit.

Z. Forsteri, gathered on trees in the south of England, is very rare. Found on sandstone rocks in Cheshire and Yorkshire, and known only as a native of Britain and Abyssinia, is *Orthodontium gracile*, the slender Thread Moss. The beautiful and distinct Thread Moss, *Bryum Tozeri*, is one of the rarest of the genus, and is also found in Sardinia.

Among the largest and most elegant of the acrocarpous Mosses is the genus Mnium, Thyme Thread Mosses. They are conspicuous for their large and broad leaves, and have oval or oblong drooping capsules with double peristome of sixteen teeth each.

Very common in wet shady places by rivulets, springs, &c., and varying in size from $\frac{1}{2}$ to 3 inches in height, is *M. punctatum*, the dotted Thyme Thread Moss.

The leaves are roundish obovate, with a thick and opaque entire border, nerve ceasing at or near the apex; capsule shortly oval and solitary. (Fig. 24.)

A very much smaller species is *M. cuspidatum*, the pointed Thyme Thread Moss, found on shady rocks and walls, especially in limestone districts.

Not infrequent in bogs and marshes, but more slender and delicate, although long overlooked as a variety of punctatum, is *M. subglobosum*, the round-fruited Thyme Thread Moss, and only recorded for Yorkshire and Sussex is *M. orthorhynchum*, the short-beaked Thyme Thread Moss.

Growing on heaths, banks and stream sides, and not by any means rare, is *Entosthodon ericetorum*, the narrow-leaved Bladder Moss: it is very interesting from the fact that it is considered on the authority of Sir J. E. Smith to be the *Hyssopus Solomonis*. "Hyssop on the wall," of Hasselquist, the learned botanical traveller, whose specimens are still preserved in the Linnæan herbarium.

Almost stemless, and with no leaves except those which constitute

the floral envelope, is *Discelium nudum*, the raked Apple Moss. It is found on clayey declivities near Manchester, and near Todmorden, also in Scotland.

Of the Fissidentaceæ, or Flat Fork Mosses, three are in fruit in the early spring, all with terminal fructification. See Vol. 2. p. 272.

One of the smallest of this genus is *F. exilis*, the slender Flat Fork Moss. The stems are only $\frac{1}{8}$ inch. in height, and recognised by the denticulate leaves destitute of border.

F. bryoides, the common Flat Fork Moss, is frequent on shady banks, &c., with stems $\frac{1}{4}$ to $\frac{1}{2}$ in. high; leaves widely lanceolate, apiculate, with a thick cartilaginous border, dorsal wing broad at the base; nerve sub-excurrent; capsule elliptical, erect; lid conical-acuminate; barren flowers axillary. In similar localities with incurved capsules is found *F. incurvus*.

Connecting the acrocarpous with the pleurocarpous is a class

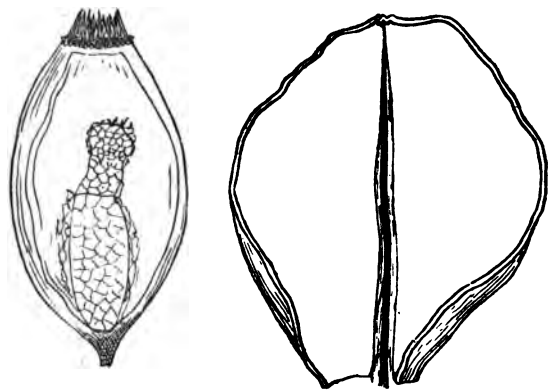

Fig. 24.

termed cladocarpous, having fruit terminal on a branch. To this class belongs *Cinclidotus fontinaloides*, the smaller water Screw Moss, growing on rocks and stones in rivulets, and on the borders of lakes, and easily recognised by its abundant immersed capsules; also *Hedwigia ciliata*, the hoary branched Beardless Moss, growing in extensive patches on exposed mountainous rocks; the ovato-lanceolate, papillose leaves are diaphanous and ciliated at the apex.

Of the pleurocarpous Mosses *Habrodon Notarisii* is found only on trunks of the elm and white thorn; a well-known locality for this Moss being Killin in Perthshire.

Rare in fruit and peculiarly Scotch, although found also in Ireland is *Pterigynandrum filiforme*, the thread-like Wing Moss.

Thuyidium abietinum, the Spruce tree Feather Moss, is very

appropriately so called. It does not fruit in Britain, and is often confounded with *T. Blandovii*, a very rare Moss, and respecting which a very interesting correspondence took place between Wilson and Dr. Hooker. Found only on the Scottish mountains is *Brachythecium reflexum*, named from the reflexed margins of its leaves; while the curved capsule gives the specific name to *Eurynchium circinatum*, the curved Feather Moss.

A very minute and rather rare species growing in dark green patches on moist shady rocks throughout Great Britain and on stones in Miller's Dale, Derbyshire, is *Eurynchium Teesdalii*.

Found on limestone rocks and stones, but not fruiting in Britain, is *Rhynchostegium depressum*, and on the sandy shore at Southport *R. megapolitanum*.

The beautiful and extremely common species, *Plagiothecium Borrerianum*, the elegant Feather Moss, grows in extensive shining green patches on shady banks and rocks, and is usually barren. Stems prostrate with complanate branches; leaves complanate, ovate-lanceolate, oblique, tapering to a slender serrulate point, nerveless or two-nerved at base; margin plane capsule ovate, more or less pendulous; lid conical, shortly rostellate; dioicous.

Amblystegium Sprucei, found at Teesdale and at Todmorden, is rare on shady sub-alpine rocks, and on wet alpine rocks is *Hypnum sarmentosum*, the twig Feather Moss.

A NEW ONE-SIXTH OBJECTIVE.

By A. Y. Moore, M.D.

A FEW months ago the Spencers constructed a homogeneous immersion $\frac{1}{10}$ inch objective of 125° balsam angle, which was the best they had ever made, and it certainly was a lens deserving of praise.

Some time after the completion of the formula of this $\frac{1}{10}$, they were requested by me to make a new homogeneous $\frac{1}{6}$ in., in which resolving power should be held paramount, and which should excel both the new $\frac{1}{10}$, and their $\frac{1}{6}$ of 120° b. a. The new $\frac{1}{6}$ would, of course, necessitate a new formula, and that of the $\frac{1}{10}$ was modified and adapted to the power of the $\frac{1}{6}$.

The Spencers assured me that this $\frac{1}{6}$ was positively the best objective they had ever looked through, and as a few words concerning it may be of interest I will describe it.

The mounting is similar to that of the old $\frac{1}{6}$, of red brass and gracefully proportioned. By means of a graduated screw collar a rectilinear motion is given to the back systems sufficient to

bring about the proper correction for use with water, glycerine, or homogeneous fluid, or for a considerable length of draw tube. The magnifying power—measured at ten inches from the front lens—is, at the open point, 63, at the closed point 70 diameters. The angular aperture is given as 130° in balsam, and is constant throughout the entire range of the collar—if the same fluid be used. The residual colour is somewhat greater than is usually seen in Spencer's objective; but still it is well corrected, and the field is flat.

This objective is remarkably sensitive as regards spherical aberration, and a slight change in length of body, or so called homogeneous fluid, makes itself known by a disturbance of the spherical correction.

The special quality desired — that of resolution — is not disappointing. The diatoms of Möller's balsam plate are easily resolved—No. 16 in dots by central light, and No. 18 in dots by oblique light—lamplight.

Accepting the orthodox view, it would seem unreasonable to expect such an objective to do well on histological work, but, on the contrary, it works beautifully. The circulation of blood in a frog's foot is beautifully shown with this glass—using it, of course, as a water immersion, without covering glass, and with powers as high as 1,000 diameters. The white corpuscles can be seen better than with any narrow angled glass with which I am acquainted. I regard a frog's foot as a very good histological test. The circulation of blood and contraction of the muscles in the leg of *Ranatra fusca* are also beautifully shown by this one-sixth.

It seems to me that it is a great mistake to put a wide-angled objective—even though it be homogeneous immersion—in a non-adjustable mount, for it so frequently happens that the length of body or density of the immersion fluid varies from that for which the objective was originally corrected, and in such cases the best performance of the objective is lost. Not only should it be adjustable, but it should have sufficient range of adjustment to correct for water, as water is far better suited to work over temporary slides than either glycerine or homogeneous fluid.—*American Monthly Microscopical Journal.*

NOTES ON THE STRUCTURE OF THE DIATOMACEÆ.

By E. W. Burgess.

THERE have been in many scientific journals, from time to time, notes upon the structure of the Diatomaceæ; many persons have ventilated their opinions, some have given drawings, others photographs; but nothing is yet decided upon the subject.

I do not think that I can do much in that way, but wish to record a few observations of my own; and also, some original drawings (unpublished), supposed to be by Dr. Walker Arnott, having been found by myself in a book of his in the Glasgow University. Papers on Diatomaceæ, Vol. 3; article, "Rylands on Markings of Diatomaceæ," on the margin of the second page, copied by permission of J. B. Balfour, Esq.

One of the earlier remarks on Structure is by Shadbolt, Trans.

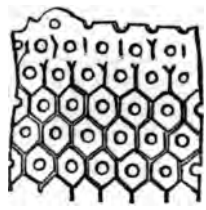

Fig. 25.

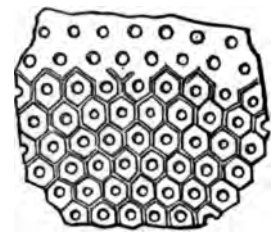

Fig. 26.

Micro. Soc., 1849 (Vol. 3, p. 49), proving that a frustule of Arachnoidiscus consists of four discoid portions, and of two annular valves (connectives) in which he is followed by F. Kitton,* and C. Stodder.† This may also be seen in Heliopelta, and in *Coscinodiscus oculis iridis*. W. Pring‡ has made sections of the latter diatom in question, by slicing thin rock sections of diatomiferous rock, from Nykjobing, Jutland (Cementstien), showing that the diatom is covered with a reticulated design,—the result of the super-position of two layers (Fig. 25). The upper part, formed of hexagonal cavities, resembling the alveoli in a honeycomb, and the lower, composed of small areolæ, convex according to some, concave according to others, placed each in the centre of one of the hexagonal depressions. I have also the same diatom in a diatoma-

* O. J. Mic. Stud. (Vol. 8), N. 5, p. 15, and Sci. Gos., 1877, p. 65.

† Lens. Chicago, 1872, p. 3. ‡ Ann. Soc. Belg. Mic. mem. vii., 1880.

ceous deposit (Monteroy, U. S. A.); but in my case, the hexagonal disc was in the interior of the "frustule," while the outer consisted of a thin plate, with an areola in the centre of each hexagon. Decidedly not an opening! as the definition given by objectives 1 in. to $\frac{1}{10}$ of an in. immersion, and $\frac{1}{12}$ ditto, gave a different aspect through the areolæ than the field outside the valve.* Fig. 26. They are considered by M. Pring as openings! He also states that *Trinacria Regina* was in the same way found to be crowded with small circular apertures! as was evident in the fractures, which had the same aspect as those of *Coscinodiscus*. I also examined *T. Régina* and *excavatus*, *stictodiscus*, and others from the Jutland slate, and came to the conclusion that M. Pring had been led astray, and considering the different opinions held by many persons about the markings of diatoms, one opinion so opposite to the other, it is very troublesome to come to a definite conclusion on the subject.

M. Pring remarks, "as to the small points or circles, figured on

Fig. 34.

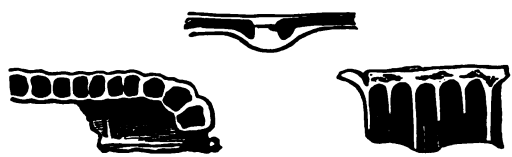

Fig. 27. Fig. 28.

the surface of the pretended elevations by certain authors. They are due to the effects of diffraction, and disappear when an open areola is examined." Now, if we examine a valve of *Tri. Regina* or *excavata*, by direct light through the valve, focussing sharply to the flat surface of the valve, we get to the edge of the base of the areolæ, and viewing the areola, find that the colour is different to that of the field (outside the edge of the valve), proving that we are looking through the substance of the areolæ; and if the valve has its exterior towards the observer, we have to withdraw the objectives by the fine adjustment to reach the apex of the areola; and if the interior is towards us, we lower the objective by the same means to reach the bottom of the pit, or concavity of the areola.

The same observations apply to the valves of *Stictodiscus*, *Triceratium*, and others.

If these diatoms are viewed by reflected light† on a black back-

* Fig. 26. Specimen in my cabinet.

† See also J. Deby. Bull. Soc. Belg. Mic. vii., 1881, pp. 79 to 82.

ground (if the valve has its exterior towards the observer), the areolæ catch the light, and would convince, I think, even the most sceptical observer, that they are not openings, but either pits or spherules, such observations depending upon the side of the valve towards the observer.

Figs. 27 and 28, drawings of *Pinnularia*, by Dr. Walker Arnott, evidently from some portions of broken valves, giving an idea that the "costæ" of the *Pinnularia* are cavities in the interior of the valve. Since I found the drawings, I have hunted over many slides in search of broken valves to bear out the point, and have found but few instances of that conformation, on account of the difficulty of finding portions of the valve in the same position. An appearance of depth of the costæ may be got by oblique light, as in Fig. 29, on almost any slide.

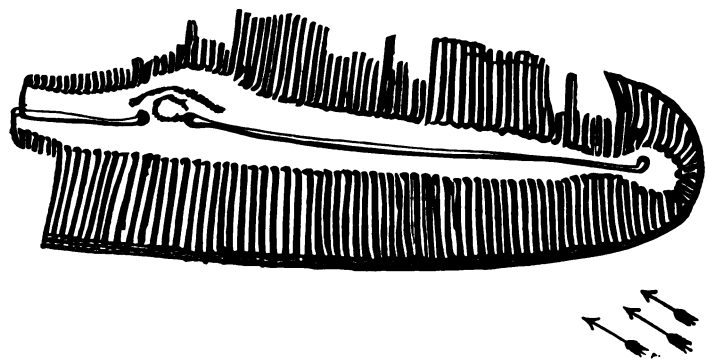

Fig. 29. Beam of light from mirror.

M. J. H. Flözel* has made sections of *Pleurosigma angulatum*, *Balticum*, and *scalprum*, and in his illustrations has given us sections of the Pleurosigmas, with cavities in the interior of the valve, similar to those of the Pinnularia, by W. Arnott, with magnifications from 1,920 to 5,000 diameters (Figs. 30, 31, 32, 33).

Prof. W. Smith, (Syn. Brit. Diat., Vol. 1, p. 61) has foreshadowed the idea (1856):—"Some observers having considered these appearances of striæ to arise from series of perforations, and others from rows of beads, or minute elevations. With the latter, I have been disposed to coincide, until, aided by the careful manipulation and excellent object glasses of Mr. Richard Beck, who has shown me the hexagonal outline of these supposed beads, I have been

* Arch. Miter. Anat. vi., 1870, p. 480, etc.

led to conclude, as I have stated in the introduction, that the lines arise from internal structure."

But there is a peculiarity connected with the drawings of M. Flözel, I wish to draw attention to, viz., that there is no canal *in the mid-rib.* If attention is drawn to the mid-rib (Fig. 29), it

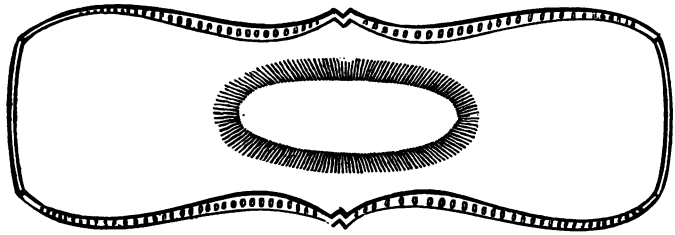

Fig. 30.

will be noticed that parts at each end of the centre punctæ overlap that which is supposed to be the "canal" laying between the overlapping parts. Schuman, in his Hohen Tatra; Dr. Donkin,

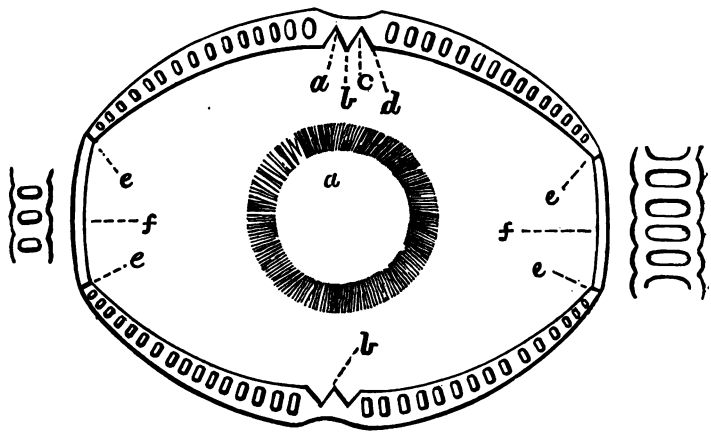

Fig. 32. Fig. 31. Fig. 33.

Brit. Diat., and Prof. W. Smith, Syn. Brit. Diat., in their drawings of Pinnularia, have given us an intimation of such "canals."

Mr. F. Kitton,* and Prof. H. L. Smith, speak of the communication with the exterior being, "through minute apertures at the termination of the 'raphe,'" or median line. Also, Mr. L. Hard-

* *Science Gossip*, 1878, p. 128.

man says that decidedly they are canals. . . . . And in the Aulacodisci this may be by means of the processes which are apparently perforate; but in the Triceratia, Coscinodisci, etc., I think Mr. Deby's suggestion, that it takes place at the margins of the connectives, is probably correct. The latter opinion is most probable, and the opinion I am inclined to hold.

C. Gunther's photographs show openings in *P. angulatum*, Dr. Woodward's photographs show elevations, and much of the disputing about spherules, &c., may be accounted for by alterations of the light upon or through the object, giving different appearances to the observer, also by the person, either drawing or photographing an appearance without properly understanding the structure of the object he is at work upon.

Fig. 34. Evidently a drawing of the central nodule of Pinnularia. I have no remarks upon it at present, not having seen that view of a diatom. The original drawing is by Dr. Walker Arnott.

REFERENCE TO FIGURES.

Fig. 25. Oblique section, *Coscinodiscus oculus iridis*. M. Prinz.

Fig. 26. Portion of valve, *Coscinodiscus oculus iridis*, $\frac{1}{10}$in. E. W. Burgess.

Fig. 27. Section of *Pinnularia*, shewing cavities. Dr. W. Arnott.

Fig. 28. *Pinnularia* (portion of broken valve) single layer septa broken. W. A.

Fig. 29. *Pinnularia* (broken valve) shewing alternating ribs and cavities. E. W. B.

Fig. 30. Cross section of *Pleurosigma angulatum*. J. H. Flögel.

Fig. 31. Cross section of *Pleurosigma Balticum*. J. H. Flögel.

a. Depth.

b. Midrib.

c. Flat poreless stripe.

e. Connections of the valve with the cingulum or connecting membrane.

d. Chlorophyll.

Fig. 32. Enlarged portion of Fig. 30.

Fig. 33. Enlarged portion of Fig. 31.

Fig. 34. *Pinnularia*, median line (nodule). Dr. W. Arnott.

NOTE.—Of the so-called areolæ in Coscinodiscus an example may be taken. Dr. Griffin of Bristol discovered, and has shown to the writer that the areolæ (?) of the *Coscinodiscus excavatus*, Fossil earth, Newcastle, Barbadoes, if viewed in the same manner as the beetle's eye, will give a figure for each spherule or areola. Query,—are not the areolæ lenticular?

CARBOLIC ACID IN MOUNTING.

By William J. Pow.

IN our last number there appeared an article on the subject of mounting without pressure, taken from an English periodical. In that article the advantages of the method described were well set forth, and no reader can fail to appreciate the value of any process which enables us to remove the air from an object without drying it, and causing it to become hard, and readily injured by handling. The method there described is an excellent one when the insect to be mounted is opaque, and of considerable size. The use of the soda-solution is to make the opaque portions transparent, and it softens the hard parts.

There are many insects which do not require the use of the solution of soda, and even among those that do require it to render them quite transparent, may still make beautiful objects when mounted in balsam by the method to be described in this article. For ourselves, we do not like to use alcohol in mounting insects, because it hardens the parts, making them stiff, and not as readily arranged as may be desired. In the case of vegetable tissues it is sometimes objectionable for the same reason. An excellent substitute for alcohol, and one that can be universally used in its stead in mounting, is carbolic acid. Contrary to the general opinion carbolic acid is not an acid, and the name is misleading. It has no acid properties whatever. Chemically speaking it is an alcohol, belonging to a series of alcohols quite different in composition from common ethyl alcohol, which we use, and from wood spirit, which is closely related to common alcohol. But carbolic acid is, nevertheless, a true alcohol, and for this reason it can be frequently substituted for ethyl alcohol in microscopical work. But what advantages has it over the latter? One great advantage is found in the readiness with which it penetrates a specimen, and mixes with the fluids used in mounting, such as water, glycerine, and Canada balsam. Another is, that it does not harden tissues and make them stiff. For this reason insects, or parts of insects, can be preserved indefinitely in carbolic acid, in a fit condition to be mounted at any time. The more delicate parts are made quite transparent by long soaking in the solution; but this is no detriment to them.

It is our custom, when going out in the country, either for a walk, or to collect objects for the microscope, to carry a small wide-mouthed bottle along, about half full of carbolic acid. Into this we immediately drop any minute insects we may find. The acid kills them instantly, and in most cases their legs are not

found doubled beneath them, as in all other methods of killing with which we are acquainted.

The acid used for this purpose, or for mounting, should be the strongest solution,—having just enough water in it to keep it fluid at ordinary temperatures. To use it for mounting it is only necessary to drop the specimen into the acid, and in a few moments transfer it to the prepared cell containing the medium in which it is to be mounted. Suppose it is desired to mount a mosquito, or a plant-louse, or any minute insect which requires no preliminary treatment, drop the insect into the acid, and in a few minutes it will be seen that the fluid has thoroughly penetrated the body. Then it is quite immaterial whether the specimen is to be mounted in water, or glycerine, or balsam, for carbolic acid will mix as readily with one as with the other. Fill the cell with the medium to be used; place the specimen on a clean slide, and take up the excess of fluid with blotting paper; then transfer it to the cell and arrange the parts with needles, when the cover-glass can be applied.

When deep cells are required for balsam mounts we are accustomed to using brass curtain-rings, cemented to the slide with shellac, or with hard balsam. Shellac is preferable if asphalt varnish is to be used to finish the mounts. After the cover is applied the slide may be gently heated until the outside balsam is hard enough to keep the cover in place. Then the excess of balsam can be cleaned off, and a ring of shellac applied to protect the balsam, when the brass ring may be concealed by any finishing varnish. The same cells may be used for glycerine or water mounts.

Another way to make deep cells for balsam is as follows:—Build up a cell of adequate depth for the object, by successive layers of benzole-balsam, and let this harden thoroughly. Then fill it with soft balsam, and mount as before. As a precaution against injury to the cell three pieces of thin glass may be placed within it to support the cover. Such a cell can be finished with damar varnish, and makes a very attractive mount.

When insects require any preliminary treatment to make them transparent, the soda solution should be thoroughly removed by washing with water, after which the specimens should be taken out one by one, the superflous water removed with blotting paper, and then thrown into the carbolic acid.

This method of mounting is the simplest and best one we know of. If the reader chooses to experiment with it let him take the head and proboscis of a blow-fly, or any part of an insect that may be available, and, without any preliminary treatment, place it in carbolic acid, and mount it in balsam without pressure. A single trial of this kind will convince him of the ease with which excellent

mounts can be made; and every one who tries it will be a convert to the new method of mounting without pressure.

We have used carbolic acid instead of alcohol in mounting stained sections of wood, with excellent results, and it is much cheaper than alcohol.—*American Monthly Microscopical Journal.*

BRITISH MARINE POLYZOA.

By A. S. Pennington, F.R.M.S.

Abstract of a paper read before the Bolton Microscopical Society, January 15th, 1883.

AMONGST the varied objects of the Microscopists' study are two groups of organisms, formerly associated together, and which resemble each other in the beauty of their external structure, and, to some considerable extent also, in apparent organisation. The components of each group, for the most part, inhabit curiously wrought cells, though in the one group the cell is merely the habitation, whereas in the other group it is part of the animal itself. Each group also is made up of animals which are noticeable for the crown of tentacles encircling the mouth, though the purposes of these crowns are different. The one group, the Hydrozoa, is a branch of the low-formed cœlenterate or hollow-bodied animals; whereas the other group, with which we are more directly concerned, the Polyzoa, is a subdivision of the much higher grade the Mollusca. Both these groups were formerly united as Zoophytes, or animal-like plants; and, when we look at these organisms by the naked eye, we are not at all surprised to find that early observers were mistaken as to their real nature, and were inclined to consider them to be really forms of plant life. It will be needless here to detail the long conflict of opinion which prevailed about the middle of the eighteenth century as to the nature of the Polyzoa and other Zoophytes. Their animal nature was ultimately settled in a peculiar way, which shows us that important facts are often found out in an unexpected manner. John Ellis, a London merchant, who occupied his leisure hours with the study of natural history, published in 1754 a communication to the Royal Society, in which he described and carefully named and figured a very large number of the Zoophytes, and very distinctly claimed for them the nature of animals. His book remains to the present a very valuable authority upon the subject; and the popular names, which he gave to the different organisms, remain to this day as their only designations. Some of these

names, as the "Birds' Head Coralline," are names which could only have been derived from accurate microscopical observations, as the peculiar features from which the names are taken are invisible to the naked eye. Ellis dedicated his book to the Princess Dowager of Wales, and informed us that in autumn, 1751, he received a curious collection of sea-plants and corallines from Anglesea, &c., and laid them out under fresh water in a manner fitted to show their ramifications, &c. These, when properly dried, he disposed on boards covered with clean white paper in such a manner as to form a kind of landscape, showing hills, dales and rocks, which made a proper groundwork for the little trees which the expanded sea-plants and corallines not inaptly represented. The Rev. Dr. S. Hales, who visited him, was so pleased with these that he asked him to make some more for the Princess Dowager of Wales, so that the young princesses might amuse themselves in a similar manner. In order to carry out this desire, he began to classify his specimens, and (happy thought) to examine them with his microscope, which he figured in his work, and which certainly makes us feel that we ought to make something out of our perfect instruments after seeing his success with his primitive lens. His attention was directed to their nature, and he went to the Island of Sheppey, taking with him Mr. Brooking, a celebrated painter of sea pieces, to draw for him. On watching the organisms alive, he came to the conclusion that the apparent plants were really "ramified animals in their proper skins or cases, not locomotive, but fixed to shells of oysters, mussels, &c., and to various fuci." In his book he describes the structure, as it appeared to him, of the zoophytes found by him, and classifies them so far as his observations would permit. From this pictorial origin we may trace a careful succession of students of zoophytes, particularly Johnston, Landsborough, Aldis, Allman, and Hincks, the last-named of whom has completely studied and classified both the Polyzoa and Hydrozoa, and his works on both subjects contain perfectly executed plates of nearly all the known British species.

The first question which we have to inquire is, What is a Polyzoon?

It is an animal allied to the Mollusca, consisting of two parts, a polypide and a zoœcium, *i.e.*, an animal and its cell; but we must bear in mind that the cell is a part of the animal. The polypide consists of a tube bent upon itself so that its two orifices approximate, the oral or mouth orifice being provided with a ring of tentacles, which are ciliated. This tube contains the œsophagus, stomach, and intestine, and on the side nearest the oral orifice is a nervous ganglion. This tube is enclosed in a sac containing fluid, which is called the zoœcium. This sac has two openings through which the tentacles protrude and the anal orifice leads—the interior lining of the zoœcium is extended so as to form a sheath to the

tentacles, which may be expanded and retracted like pulling in and out the finger of a glove, but which are connected with the zoœcium firmly, so as to leave no opening between them. In most cases the alimentary canal or tube is furnished with muscles attached to the side of the zoœcium, which can be expanded or retracted. The polyzoon contains no heart or vascular system. The reproductive organs are contained in the cavity of the cell.

The zoœcium consists of an outer wall or ectocyst, and an inner wall or endocyst. The outer wall is a simple chitinose membrane, without any apparent structure, and is a secretion from the inner wall or endocyst. This ectocyst is often strengthened by a deposit of calcareous or silicious particles, and then forms a solid wall, curiously and often very richly and beautifully sculptured. Sometimes it becomes gelatinous. The structure of this external cell is of great importance in systematic distinctions. The Polyzoa are social animals and live in colonies, which are formed by the production by gemmation of a number of these zoœcia with the polypide contents. This process of gemmation continues until the vital energies are exhausted. A connection between the soft polypides of the cells is kept up by means of perforations in the wall of the zoœcium, through which thread-like prolongations of the endosarc pass, and which serve to connect together all the members of a colony. The perforated portions of the ectocyst are called "communication plates." In one branch of the polyzoa the communications are at the bottom of the cell, and proper circular perforations are made in the diaphragms separating the different cells. In *M. membranacea* a curious modification of the ectocyst occurs, certain parts of every zoœcium being flexible. By this means the organism is enabled to bend and adapt itself to the varying position of the seaweed upon whose fronds it is found.

The endocyst is a delicate transparent membrane without any cellular structure. It is, in fact, a simple layer of protoplasm lining the ectocyst. Connected with the endocyst is an arrangement of muscles or fibres, which, by their contractions, are instrumental in compressing the membrane and reducing the dimensions of the cavity of the zoœcium. These are called the parietal muscles. The zoœcium is a more or less solid outer wall lined with living membrane, in which the polypide lives. The different parts of the polypide are, (I.) the tentacles and sheath; (II.) the alimentary canal; (III.) the nervous system; (IV.) the muscles.

I. The corona, or crown, is a bell-shaped wreath of tentacles borne on a circular stage, called the *lophophore*, occupying the summit of the body and perforated by the mouth. The mouth is a simple orfice opening into the œsophagus, and so placed as to form the focus of the food whirled down by the action of the tentacles. The tentacles are hollow, closed at the extremities and

opening inwards into the cell cavity. They are covered with vibratile cilia, ranged in a single line along each side, and serving to produce ciliary currents. These cilia project from cells with large nuclei, which line each side of the tentacle. The tentacles vary in number from 8 to 80. These tentacles perform functions which are of great importance. They are really respiratory organs or gills, and it is the possession of this feature which really assigns the polyzoa to their place so high in the animal scale as the Mollusca. They are also tactile organs, and receive all the impressions from without which the zooid is capable of receiving. They are capable of very active movements, and are provided with an admirable and effective service of muscles. A pair of these muscles in the form of a collection of fibres being found in each tentacle. The tentacular sheath is a membranous expansion of the anterior part of the zoœcium, and is attached by its end to the base of the tentacles. The movements of the polypide are limited to the expansion and retraction of this sheath and the consequent extension and retraction of the tentacles. The cavity of the cell is sealed. By the "orifice" of the zoœcium is meant, not an opening in the ordinary sense of the term, but that opening in the structure of the zoœcium through which the tentacular corona and sheath may be protruded. The orifice is a very important element in classification.

II. The alimentary canal has three well-marked divisions. The œsophagus, the stomach, and the intestines. The mouth opens into the œsophagus, which is thickly clothed with cilia, which assist in sending the food downwards into the stomach. The upper part of the œsophagus is often a very distinct funnel-shaped pharynx, and is then a very wide chamber with well-adapted muscular walls. The surface of the pharynx is dotted over with minute spots.

The œsophagus varies much in length; though generally it is a simple tube, leading directly into the stomach. In the course of the tube is placed a valve (the *cardia*), which is a conical perforated projection with the free end downwards. This marks the entrance to the stomach, and is so placed as to prevent the return of any food once received into the stomach.

The œsophagus is furnished with transverse muscular striæ, which by contracting the tube aid in forcing down the food. The stomach is contracted by similar muscular means. The stomach is a sac or bag, wide above and more or less pointed below. It has thick walls of a rich yellowish brown colour, due to the pressure in its lining membrane of numerous glands, which perform the functions of a liver and secrete a brown fluid, probably of biliary action. The intestine opens out of the stomach at its upper end near the œsophagus. The entrance to the intestine is guarded by the pyloric valve performing similar functions to the cordia. This valve is sometimes placed at the summit of a conical chamber,

called the pyloric vestibule. Here the food is formed into pellets prior to ejection. The pyloric vestibule is richly ciliated.

In some species of polyzoa, between the œsophagus and the stomach is found a gizzard, which is an enlargement of the cardiac portion. The walls are much thickened, very muscular, and provided with pointed processes called gastric teeth.

III. The nervous system is present in a very rudimentary form. It consists of a single roundish ganglion, from which nerves are given off in different directions. These nerves are very difficult to follow. They have been traced to the lophophore, the tentacles, and the alimentary canal.

IV. As may well be imagined, the muscular system of the polyzoa is complex and highly developed. The varied movements of the corona as a whole, and of the separate tentacles, of the alimentary system, of the endocyst, &c., shew that to effect them there must be present a full apparatus of muscles, and we find this to be the case. The principal muscles are the *great retractors*. These consist of two broad bundles of fibres attached to the lower part of the cell wall and extending to the base of the tentacles. In the expanded polypide they appear as two bands extending the whole length of the organism, when contracting they drag down the corona, invert the sheath, double up the alimentary canal, and bring all parts well within the cell very rapidly.

These muscular bands, though really solid, are made up of a number of fibres which separate on relaxation. The muscles of all polyzoa are simply distinct fibres which never unite in the manner observed in the higher animals. The fibre appears striated in some of the larger muscles.

The interior of the animal, *i.e.*, the space between the endocyst, in which the alimentary canal is suspended, is called the *perigastric cavity*, which is always filled with fluid in which float a large number of corpuscles of various shape and size, and into which are discharged the spermatozoa. Within this cavity the reproductive organs are lodged, and here the ova passes through their stages into the larval forms.

This fluid has been analysed in one or two cases and found to be a concentrated solution of common salt, with traces of albumen. It may be assumed to consist in all cases of water and the products of digestion, though how these get into the cavity is not known. The only hypothesis is that they traverse through the walls of the alimentary canal.

The particles are the cells of the endosarc, and have been compared to the blood corpuscles of the lower animals.

The perigastric fluid extends into the tentacles, where, as in a system of gills, it is aerated by the water.

At the lower part of the cell, and connecting the base of the

stomach with it, is a contractile cord, called the *funiculus*, which plays a very important part in the economy of the animal. This structure extends for a considerable distance along the walls of the stomach, and gives off filaments which reach to the endocyst. The funiculus expands a little at the base of the cell, and thread-like prolongations extend through the base through the pores of the diaphragms to the cell beneath, so forming a connecting link between the various portions of the *Zoarium* or colony. The structure of the funiculus is uniform, and composed of cells very much resembling in shape the frustules of the diatoms *Navicula.*

This funiculus is sometimes called the endosarc. Fritz Muller considered this endosarc as a colonial nervous system, and so described it, and his views were until recently very largely accepted. He considered it a great series of nerves serving not for the individual structures, but for the entire colony. Recently, however, this structure has received considerable attention from Reichest, Joliet and others, who have very strongly opposed the nervous theory of Muller, and hold that the funiculus is a derivative from the endocyst. This view is now generally adopted. The spermacyst is developed on the endosarc and the spermatozoa, and in many cases the ova proceed from it. The endosarc may, therefore, be looked upon as an extension of the endocyst, in which the cells are altered so as to form distinct shapes, and to have special functions specially connected with the reproduction of the animal and the union of the colony.

In those polyzoa in which the orifice of the zoœcium is protected with an opercular covering, *i.e.*, in the *Cheilostomata* there are a number of curious appendages known as *avicularia*, or "bird's head" processes and *vibracula.*

There are forty-five British genera of Cheilostomata in thirty-one of which are found avicularia, and in four of which vibracula are present.

This bird's head process differs in shape very much, varying from a slight differenticled zoœcium to an elaborate structure like that of the Bugulæ. This structure is one which—viewed in any one species without consideration of others—would cause considerable difficulty in deciding its nature, but when the avicularia generally are considered it is found that a development of form can be clearly traced, which shows that the avicularia were originally slightly modified ordinary zoœcia, and that through a multitude of phases they have passed in some species to highly specialized organs. In these avicularia are found an apparatus of muscles, and in most of them is found a cellular body, the analogue of the polypide. This polypide contains a nerve centre, and probably constitutes an organ of touch, as it is supplied with an apparatus of *setæ* or bristles. The use of these appendages is

much questioned. Some have regarded them as food providers, and they have been observed to hold small worms, but as they cannot transfer the worms to the mouth they are useless for this purpose, and are now regarded as defensive in their functions—serving to drive away by their appearance or movements any enemies of the colony.

The *Vibraculum* is a chamber in which muscles are lodged, and contains a moveable bristle. This is of rare occurrence, and is generally placed in such a manner as to sway backwards and forwards across the opening of the zoœcium, and may serve the purpose of keeping clear from hindrances and accumulations of matter the entrance of the cells.

The reproduction of the polyzoa is of two kinds—sexual and asexual. In the latter case gemmation is the *modus operandi.* The reproductive elements have already been explained as having their origin in the endosarc, and their position in the perigastric cavity. In some species there is an intertentacular organ or opening between the tentacles to allow of the escape of the spermatozoa. The ovary contains sometimes thirty ova—sometimes only two. After fertilization the usual course of segmentation takes place—resulting in a free ciliated larva. In many species of the *Cheilostomata* ovicells are developed in the breeding season, at the upper extremity of the cell. This usually occurs by gemmation from the wall of the zoœcium. The interim is in direct communication with the perigastric cavity. These ovicells serve, according to Professor Huxley, for marsupial chambers, where, after fertilization, the ova develop into the larva, and from whence the larvæ escape into the outside world. The larvæ are varied in form—some singularly beautiful in colour, and some are even furnished with a bivalve shell. They are restless in their habits, and are richly ciliated. After a while the restlessness ceases. The larva settles down into an apparently homogeneous mass, which is the first zoœcium and polypide, and assumes the perfect form after a process of histolysis.

The Polyzoa are also reproduced by gemmation, which is continuous—the different cells (except in Loxosoma) not falling off, but continuing as part of the colony. The buds are produced from the endosarc, and speedily assume the perfect form.

Having now described the structure of the Polyzoa it remains to enquire into their place in nature. Linnæus classed them as worms in common with Hydra, tape worms, Volvox, and others. It will be needless to follow the many classifications since his time, but it may be pointed out that at present some writers consider them as worms, others as Rotifers, others as Cœlenterata, and others, including Milne-Edwards, Agassy, Allman, Huxley. Ray-Lankester, Hincks, and others, assign them to the Mollusca,

or to a sub-kingdom, Molluscoida. This latter view is that adopted by most English naturalists. The main reason for this view is the possession of the tentacles, which are *gill-like* in function. The possession of gills is an essentially molluscan feature, and the gills of the mollusca correspond in all essential particulars with the tentacular corona.

There are 235 species of Polyzoa found on the British coasts.

The Continental Zoologists prefer to use the name Bryozoa, a name which was first applied to them by Ehrenberg. The English agree, however, to keep the term Polyzoa, which is the oldest name — having first appeared in Thomson's Researches, published in 1830, the other term not appearing till 1831.

LIVERPOOL MICROSCOPICAL SOCIETY.

AT the fourteenth annual meeting of the Microscopical Society of Liverpool, held in the Royal Institution, Colquitt-street, Mr. Frank T. Paul, F.R.C.S., was elected president of the society for the year 1883 in succession to Mr. W. H. Weightman, whose term of office had expired.

At the outset of his inaugural address the new President said—With a roll of nearly 200 members, with microscopes of the most perfect description amongst us in plenty, with long winter evenings for some months to come, and with material of all kinds abounding, I consider that our opportunities are enormous, and we only need that some happy spirit of enthusiasm should be diffused amongst us to show that our capabilities are no less. With us the microscope is a study rather than a recreation—a study, to be sure, so pleasant that we regard it in the light of a recreation, but still so scientific that we must devote our best energies to it. I do not wish to speak too strongly, but I think that in point of usefulness, in point of elevating and increasing the scope of our minds, it would be better for a society such as this never to have existed at all than to consist of members who regard the microscope as a scientific toy. With the public generally it is so, and it is well enough that it should be so; but we, by forming ourselves into a society, make, I consider, a profession of special interest in the subject with which it deals, and, therefore, we ought to regard it as incumbent upon us to do something—indeed, as much as in us lies—to further it. And of all the scientific studies, from the simplest to the most abstruse, there is none that is more

fascinating in its pursuit, that is more suitable to every one, or that has a more universal application in every department of nature, than that of microscopy. When I speak of its general suitability to every one I most certainly mean to include the ladies. If there be a scientific pursuit for which they are in every way fitted, and in many ways eminently so, it is this. And at the present time, when they are urging their just claims for a higher education, when they are more than ever desirous of pursuing the more active callings of life, microscopy opens out to them at once as a field for scientific investigation, quite unaffected by any distinction of sex, and with scope for every variety of intellect; or, if they will, as a means of earning a living as professional mounters, or as artists capable of sketching microscopical specimens. But it it is not to ladies only that I have to appeal for work. There is another section of our society to which, with good reason, we look for an abounding freshness and energy, and that is our younger members. I do not wish to inquire too closely why they became members, for some of the reasons would not, I fear, altogether coincide with my idea of their responsibilities to the society which they have joined. At least every one pays a subscription to help to form an audience, and that is at any rate useful to us if not altogether creditable to the individual. But what I wish to impress upon them is that they constitute our future, and, therefore, as every year brings with it its new members we look amongst them for steady workers, who may be relied upon to maintain the efficiency of the society. It needs no marvellous intellect, no special brilliancy, to succeed in a scientific study. Work at it ardently and perseveringly, and success will follow. And in nothing more certainly than in microscopy. In a society so admirably constituted as this is—with so energetic a committee; with a treasurer who always presents us with a balance on the right side; with a secretary whose self-sacrificing devotion has placed the society under everlasting obligation to him; with every convenience for lectures, discussions, and conversaziones; and with what is a frequent desideratum, a large and enthusiastic audience; let me hope that the time you have honoured me with the leadership will be one of the greatest success in our history, and that I am now inaugurating a session that shall be remembered, not for the brilliancy of its lectures or the beauty and variety of its conversaziones—for in such matters recent sessions can hardly be surpassed—but for the number and enthusiasm of those who devote themselves thoroughly and perseveringly to the scientific use of the microscope.—The remainder of the address was upon the histological character of the nervous system, the subject being illustrated by photographs from exquisitely-cut microscopic sections, and illuminated by the oxy-hydrogen lantern.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

SUBSCRIPTIONS FOR 1883. The current year's subscriptions became due in Jan. last. In remitting the amounts, will subscribers kindly fill up the enclosed form?

THE MANCHESTER MICROSCOPICAL SOCIETY. — The usual monthly meeting of the mounting section of this society was held on Wednesday evening, February 14, at which Mr. Henry Hyde exhibited a specimen of *Branchiostoma lanceolatus*, a fish remarkable for the rudimentary condition of its organs. He also showed specimens, in preservative fluid, of the frog in all its stages of development, from the ovum to the perfect animal.

Mr. W. Stanley then proceeded with mounting in glycerine jelly without boiling; the objects dealt with being the inflorescences of several typical mosses, the flowers of which he dissected and explained.

In the senior division Mr. A. Hay was the demonstrator, his subject being "Animal Tissues, and their Treatment," in which he showed the various operations, such as preserving, hardening and softening, freezing, and embedding, necessary in the preparation of such tissues.

Sections of the heel, kidney, cartilage, and bone, and also tongue of cat were cut, and stained, and mounted in balsam by Mr. Miles, and the slides distributed amongst the members present.

At the January meeting of this society Mr. W. Blackburn, F.R.M.S., made some remarks on an address which Dr. Carpenter lately delivered at Montreal to the microscopical section of the American Association for the Advancement of Science, and the views explained therein as to the best object glasses for biological work.

Dr. Webber followed with a communication on "Empty Amplification."

Mr. Henry Hyde gave an account of the development and formation of the plant embryo, illustrated by diagrams and specimens. The paper dealt with numerous interesting points, such as the essential organs of the flower; the pollen substance and the growth of pollen-tubes containing the fertilizing element; the origin of the nucellus with the embryo-sac, and the nature of the

oosphere or germinal-vesicle. The latter was stated to be the body destined to become the embryo after fertilization. This process was explained as being the coming in contact of the pollen protoplasm with the oosphere, which causes it to undergo numerous and important changes, all of which result in the production, in the higher plants, of the cotyledons, plumule, and radicle, these constituting the embryo. The embryos of the oak, beech, sycamore, and scarlet runner were shown, as were also a number of diagrams illustrative of the development of the embryro of the common shepherd's purse.

ASHTON-UNDER-LYNE FREE LIBRARY.—We have great pleasure in noticing a very interesting pamphlet just received from Mr. Daniel F. Howorth, of Ashton-under-Lyne. It is entitled "The Natural Sciences as Illustrated in the Ashton-under-Lyne Free Library," and is intended not only to inform readers in science what books likely to be of service to them are in the library, but also to point out the plan of classification, and save much labour in looking for any particular volume. We think Mr. Howorth deserves great praise and the thanks of his fellow townsmen for the labour which he must have expended in this pamphlet. Ashton-under-Lyne is certainly to be congratulated upon the possession of such a highly useful collection of scientific works as we find enumerated here, and we hope the example thus set will be a powerful inducement to many other towns to render like assistance to the seekers after knowledge in their midst.

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In reference to the above we have often marvelled at the style of literature which seems to find the greatest favour in most Free Libraries: *Punch*, *Fun*, *The Graphic*, and the *Illustrated London News* generally reign supreme, and for every reader of a good sound work, whether on literature, art, or science, we find scores of individuals seeking for the latest novel. Surely this ought not to be, and the managing authorities of many of our Free Libraries —especially where the expense falls upon the ratepayers—should exercise greater discrimination in the choice of suitable works and periodicals than they do at present.

BOLTON MICROSCOPICAL SOCIETY.—The usual monthly meeting of the above society took place on Thursday evening, February 15. In the absence of the president of the society Mr. Richard Walmsley occupied the chair. After the transaction of the usual business, Mr. A. S. Pennington, F.R.M.S., delivered a most instructive and interesting lecture on "Marine Polyzoa," which may be found in abstract on page 78 of the present number. The

paper was illustrated with a series of about fifty exceedingly well executed drawings of polyzoa.

MICROSCOPICAL.—We are glad to note that Mr. Coppock, who has for years been associated with the firm of Messrs. R. and J. Beck, has opened magnificent premises at 100, Bond-street, London, where he will continue his business as a manufacturing optician. The instruments and apparatus manufactured by the firm (of which he was a member) will be supplied by him as heretofore, together with all the most recent improvements of home and foreign manufacture, and from his long experience and practical knowledge of the requirements of the student and amateur we have no doubt that he will meet with that support which his courtesy has hitherto awarded him. He promises us a full catalogue with as little delay as possible, and our knowledge of his care and ability assures us it will be well worth perusal when issued.

MANCHESTER CRYPTOGAMIC SOCIETY. — Captain Cunliffe, F.R.M.S., in the chair. Mr. J. Cash exhibited a fruiting specimen of *Leucobryum glaucum* var. *minus* gathered in the New Forest. Mr. G. Slatter sent a specimen of *Schistostega osmundacea*, which had been collected, December 30th, 1882, in the caves of Isis Parlis, Penrith, Cumberland. This pretty little moss is new to the province, and was found by Mr. Martindale. Mr. W. H. Pearson brought before the notice of the society the discovery of a new British hepatic *Cephalozia Jackii* (Limpricht), which Dr. Spruce had detected in specimens of *Jung. byssacea*, collected by W. Wilson, near Warrington, April, 1841. The species does not appear in the recently published memoir on *Cephalozia*, by Dr. Spruce. Captain Cunliffe exhibited a fine series of recently collected mosses, from Wales. *Didymodon cylindricus* being abundantly in fruit, and *Campylostelium saxicola* was exhibited as growing on loose stones. Dr. J. B. Wood sent fruiting specimens of *Eurhynchium circinatum*, and *Hypnum Bottinii* (Brudler), the latter being a new European moss. Both species were found by the Mayms in Italy.

THE MANCHESTER SCIENTIFIC STUDENTS' ASSOCIATION.—Evidently there is something wrong in this society. The following extracts are made from a letter in the *Manchester City News*:—

"Sir,—It is quite evident that there ought to be a change in this society, and none I think could foresee this so well as the late honorary secretary, Mr. George Yates. He has for ten years done all that it was possible to do for the interests of the society, but through the incapacity and petty interference of a few members,

and the want of sympathy and assistance from a sufficient number of really scientific men, he has had to make up the programme from time to time as he best could. However, there is a limit to everything, and when the work for 1882 was finished he retired in time to give the committee an opportunity of selecting another secretary for appointment at the annual meeting this month.' 'In order to restore the true and original character of the association, and to maintain its rightful dignity, in my opinion the number of the members should be strictly limited, say to one hundred, and no one, either man or woman, should be considered eligible who had not given very palpable proof of the possession of a certain amount of definite scientific information, or who was not known to be a worker in some scientific pursuit.' 'There should be no complimentary offices.' 'At the soirées or exhibitions there ought to be more real science and less shopkeeping. What does the association want with rows of microscopes or Japanese tea things? If something good could be done at the soirées, then outsiders, non-members, might have the opportunity of profiting by the payment of a fee of 5s., just as they pay to go into a flower show, a concert, or an exhibition."

STUDIES IN MICROSCOPICAL SCIENCE.—Since our last notice Mr. Cole has issued ten more numbers of this interesting series, with accompanying slides of high class. They are as follows:—

32. Diabase from South Quarry, Corstorphine Hill, Edinburgh, × 25.

33. T. section of Human Spleen injected with carmine, and stained with Hœmatoxylin.

34. T. section of the stem of *Juncus communis* (common rush).

35. T. section of the cat's spleen, stained with logwood.

36. Longitudinal section of the stem of *Euphorbia splendens*, stained with logwood.

37. Vertical section of the submaxillary gland of dog.

38. Section of Red Syenite from Ord Hill, Sutherland.

39. Illustration of human tongue, papilla, &c.

40. T. section of upper portion of leaf of *Ficus elastica*, showing cystolith.

41. Vertical section of tongue of dog, stained with logwood, and showing circumvallate papilla.

Our readers will see from this list the nature of the journal, and as Mr. Cole is making preparations for the work of volume II. he asks that intending subscribers should send in their names at once. Of volume II. no more than 500 copies will be issued, so it is just possible that the work will fetch a handsome price some day.

It is only true to say that there has never been issued a microscopical journal got up in such splendid style, and so suited to

the wants of the working microscopist as these "Studies in Microscopical Science," and we hope that the whole issue will be subscribed for early.

NORTH OF ENGLAND MICROSCOPICAL SOCIETY.—On Feb. 6th, in the Committee Room, Literary and Philosophical Society, Newcastle-on-Tyne, Mr. C. E. Stuart, B.Sc., read a paper on Crystals, their microscopical character and investigation. The basis of this paper was a series of one hundred sections of minerals of common occurrence in rocks, cut in special relation to their crystallographic axes, so as to distinguish the different systems of crystalline symmetry. This series was lent by Prof. Lebour, who at the close of the paper pointed out the accuracy of the cutting of the sections, and their special interest to students of petrology and mineralogy.

But Mr. Stuart, bearing in mind that his audience as a whole had but a minor interest in those studies, made the body of his paper bear chiefly on the general physical character of the sections under examination rather than on the theoretical speculations based on their peculiarities, and intended also that it should serve as a general introduction to the microscopic study of crystals.

To this end he commented with definitions and descriptions of crystals, the crystallographic systems, and their characteristics. The essentials of a petrological microscope were then set forth. Lastly, the striking points of the sections on the table came under consideration, as surface, cleavage, twinning, enclosures, zonal accretion, and so forth. The significance of these phenomena were pointed out, specially interesting being the light thrown on the origin of crystals and of rocks by the nature of the enclosures —either dusty matter or other crystals, or glass, or liquid, or gases fluid under strong pressure—found in the former. In connection with the purely optical effects produced by crystals, polarisation had special attention, and a short explanation of the cause of the production of the white light, darkness or brilliant colours seen when certain sections were viewed between two Nicol's prisms, brought the paper to an end.

A most excellent set of micro-photographs, a number of models of crystal forms, and the necessary microscopes for exhibition of the sections, kindly lent by Prof. Lebour, served to further illustrate the subject treated.

PERCEPTION OF LIGHT AND COLOUR BY THE LOWEST ORGANISMS. —An extremely interesting paper on the above subject, as illustrated by Navicula, *Paramœcium bursaria* and *Euglena viridis* may be found in Pflüger's Arch. Physiol, xxix. (1882) pp. 387-400.

PREPARING BACILLUS TUBERCULOSIS.—Prof. J. Brun proposes the following "ameliorations" to Koch and Ehrlich's processes:—

1st. Not to coagulate the albumen by heat, avoiding desiccation at more than 80° C. At 100° or 120° C. the bacteria are contracted.

2nd. To render the organic matter transparent by acetic acid:—Concentrated nitric acid 5 parts, glacial acetic acid 10 parts, water 55 parts.

3rd. To neutralize the nitric acid which, remaining to a greater or less extent in the organic layer, at length decolorizes the bacteria and renders them invisible. For this purpose is to be used a concentrated aqueous solution of aniline which neutralizes all the acid not removed by repeated washings.

4th. To avoid Canada balsam, the index of which (1.53) is too high, and to take a neutral liquid having the same index as the albuminoid substances (1.37):—Very white gelatine 14 parts, salicylic acid ·25, distilled water 88. This has an index of 1.356 for the yellow rays. Castor-oil can also be used, though its index is 1.46.

It is better to leave the field uncoloured than to colour it an orange-brown with vesuvine or other colouring matter, because the blue of the bacteria is rendered fainter by the complementary orange tint.—*J. R. M. S.*

MOUNTING MEDIA.—Prof. H. Hoyer has found excellent mounting media not only in L. Bach's solution of gum arabic in liquor ammoniæ aceti, but also in acetate of potash, as well as a third modification with glycerine and chloral. The two former are more particularly suitable for preparations stained with aniline colours, especially bacteria. The latter is suitable for sections hardened in chromic acid, alcohol, &c., and objects coloured with carmine or hæmatoxylin.

The solutions are thus prepared:—A high 60 c.cm. glass with a wide neck is filled two-thirds full with selected white gum arabic (in pieces, not powder), and then acetate of potash or ammonia is added, or a solution of chloral-hydrate (of several per cent.) to which 5-10 per cent. of glycerine has been added. The gum with frequent shaking dissolves in a few days and forms a syrupy fluid, which is slowly filtered for twenty-four hours. The clear filtered fluid will keep a long time, but if spores of fungi begin to develop a little chloral can be added and the fluid refiltered.—*J. R. M. S.*

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 28. *APRIL.* 1883.

THE PRESIDENT'S ADDRESS TO THE MANCHESTER MICROSCOPICAL SOCIETY.

BY W. BLACKBURN, F.R.M.S.

Read at the Annual Meeting, February 22nd.

AS it is customary on occasions of this kind, when the management of a society is submitted annually to the suffrages of its members, for an address on some subject connected with the society or the nature of its pursuits, to be delivered from the chair, I propose, upon now assuming the office to which you have done me the honour to elect me, to draw your attention to some of the ways in which the progress of natural science has been promoted by the use of the microscope, and to the advantages we have derived from microscopical research in our social relations, as affecting our well-being.

It will, of course, be impossible for me to treat this subject very fully within the limits of this short address, and I must content myself with merely noting what appear to me to be some salient points.

For a long time the physical sciences were in advance of the natural sciences, owing to the imperfect instruments with which the latter were investigated, and modern microscopical research may be said to date from the introduction of the achromatic principle into microscope lenses. Previous to this event microscopical investigations were principally carried on by means of simple lenses, the uncorrected compound instrument having fallen into disuse to a great extent, owing to the unreliable nature of some of the inferences to which it had given rise. Simple lenses appear to have been used as magnifiers from a very remote period. Aristophanes, the Grecian dramatist, who lived in the fifth century before Christ, alludes in his "Clouds" to "burning

spheres" having been sold at the shops of the Athenian grocers; Seneca, the Roman philosopher, who died A.D. 65, described the magnifying capacity of "globules of glass filled with water;" and Ptolemy, the Alexandrian astronomer, who lived about the same time, wrote a treatise on Optics, in which he described the principle of refraction in glass. In the British Museum there is a lens made of rock crystal, which was found amongst the ruins of Nineveh. The compound microscope appears to have been first invented by Zacharias Jansen about the year 1590, and the early transactions of the Royal Society, which was established in 1660, contain many records of improvements in the instrument, and discoveries by its means. The obstacles that retarded the introduction of the achromatic principle were very great. Sir Isaac Newton had announced in his "Optics" the proposition that, as all refracting substances caused prismatic colours to appear, "no improvement could be expected in the refracting telescope," and the "Newtonian reflector" became the most approved instrument of the astronomer; Newton also invented a reflecting microscope; and after the Dollonds had produced their excellent $2\frac{3}{4}$ inch achromatic object-glasses, the applicability of the principle to the microscope was disputed, owing to the small size of the microscope objective, and the difficulty of grinding small surfaces to the necessary curves, and also to the idea then prevalent that it must be an imitation of the telescope objective, and not something *sui generis*. The discovery of the achromatic principle in its applicability to object-glasses for telescopes, was first made by John Dollond in 1757—for which the Royal Society awarded him their Copley medal; but it was not until the year 1823 that any successful attempt was made to apply this principle to the microscope, when Selligues and Chevalier, of Paris, produced achromatic combinations of two or more pairs of lenses, each pair being composed of a double-convex of crown glass and a plano-concave of flint, the latter correcting the aberrations of the former, whilst a capacity for refraction remained. The first English achromatic objective was made by William Tulley in 1824. Amici, in 1827, produced an improved combination of three pairs, and soon afterwards J. Jackson Lister, instructed by the researches of Sir John Herschell and others, produced a new combination of lenses, in which he used Canada balsam to cement the lenses of each pair, and prevent the great loss of light by reflection from their surfaces. In 1837 Mr. Ross introduced the "correction collar" to the higher powers, an improvement rendered necessary on account of the excellence of the images produced by the new achromatic lenses, and the interference of the "cover-glasses" with the definition. In 1850 Mr. Lister introduced the improvement of the *triple back* and *single front* lens, (separated by a *double middle*),

which gave better correction with wide apertures; and it was soon afterwards discovered that the correction for spherical aberration depended largely upon the thickness of the front lens. The introduction of the principle of "homogeneous immersion" brought the microscope to its present high state of perfection.

This short sketch will enable you to understand that, although lenses were used for the investigation of nature from a very early period, very little could have been known previous to the beginning of the seventeenth century about the minute structure of natural objects, and that at that time the introduction of the compound instrument gave an impetus to microscopical research, which was still carried on to a great extent by means of simple lenses of an improved character. We find that during that century Malpighi discovered the corpuscles in the blood, and witnessed some forms of capillary circulation. He discovered the Malpighian bodies in the kidneys and spleen. Swammerdam invented the process of injecting the blood vessels with a coloured solidifying fluid, and investigated the minute anatomy of the bee, the "May-fly," and some other insects with considerable success; and then Leeuwenhoek came upon the scene as the pioneer of modern microscopical research. He confirmed the truth of Harvey's discovery of the circulation of the blood, by witnessing its passage from the arteries to the veins through the capillaries of several animals. He traced the anatomy of the flea, and its mode of reproduction, and disproved the assertions of his predecessors that it was produced from sand or dirt, and that animals of high organisation could be "produced spontaneously or bred from corruption." He also traced the mode of reproduction of some other animals; and whilst he confirmed the doctrine previously announced by Redi, the Italian naturalist, *Omne vivum ex vivo*, he inculcated another, *Omne vivum ex ovo*. He appears to have known that yeast contained "globules," but the imperfection of his lenses did not allow him to discover that these globules were living cells reproducing themselves by gemmation and fission, and that the lowest animals, the Protozoa, had a similar mode of reproduction. He was the discoverer of the Rotifera (wheel animalcules), and their capability of resuscitation after the drying up of the water they inhabit.

Of the anatomy and physiology of plants little was known previous to the discovery by Grew, in 1676, of the functions of the stamens and pistils. That plants had sexes was known from a remote period, for, according to Herodotus, the Babylonians recognised the difference between male and female date palms, but the organs of reproduction were unknown. The function of pollen appears to have been first noticed by Samuel Morland in 1703, and in 1736 Linnæus published his sexual system of botanical classification. He failed, however, to recognise the

sexual reproduction of Cryptogams, and his system was afterwards superseded by the natural system of De Jussieu and De Candolle. In 1782 Hedwig described the antheridia and pistillidia (archegonia) of Mosses.

Although after this time the number of facts revealed by the microscope was wonderfully increased, yet little further real advance was made in scientific knowledge by means of the microscope until early in the present century, at which time the *principles* of nature were little understood. In the words of Sir John Lubbock, "Fifty years ago it was the general opinion that animals and plants came into existence just as we now see them. We took pleasure in their beauty; their adaptation to their habits and mode of life in many cases could not be overlooked or misunderstood. Nevertheless, the book of nature was like some richly illuminated missal, written in an unknown tongue: the graceful forms of the letters, the beauty of the colouring, excited our wonder and admiration; but of the true meaning little was known to us. Indeed, we scarcely realised that there was any meaning to decipher."

A new life, however, was soon infused into microscopical research upon the introduction of the achromatic object-glass about 1825 to 1830, and since that time enormous strides have been made in our knowledge of natural science, and especially of the phenomena of life and the laws of organisation.

In 1838 Schleiden published his "Contributions to Phytogenesis," in which he showed that the life-history of the cell must form the basis of vegetable physiology; and in the following year Schwann issued from Berlin his "Microscopical researches into the accordance in the structure and growth of animals and plants," in which he showed the similitude in structure of the simpler forms of animals and plants, and how the various tissues arise, by differentiation of parts, from elementary cells. Cell-division was first described by Hugo von Mohl in 1835, who was also the first to detect, in 1846, the identity of the albuminous material (protoplasm) of vegetable and animal cells. About the same time Amici discovered the mode of fertilisation by means of the pollen-tube in flowering plants. In 1848 Suminski completed the discovery of the reproductive process in Ferns. The mode of reproduction of other cryptogams was afterwards discovered, and embryology formed a part of scientific botany.

In the animal kingdom the knowledge of embryonic life was much advanced by the discovery by Von Baer in 1827 of the ovarian ovum in mammals and man. He showed the similarity in the mode of origin of all vertebrate animals, that the development of the embryo is a progression from general to special structure, and laid the foundation of modern embryology, the recent progress of which is largely due to the methods that have been adopted of preparing

specimens for microscopical investigation by the hardening, imbedding, clearing, and tinting processes. In 1831 Dr. Allen Thomson first introduced the method of section to the study of embryology by applying it to the investigation of an early state of development of the aorta of the bird. In 1840 Hanover, of Copenhagen, began to use chromic acid as a hardening agent; and since that time later observers, with improved processes and better section instruments, have considerably extended the knowledge of this science and the art of investigation; so that it is now possible to make very thin and clear sections, several hundreds to the inch, through the smallest embryo or the smallest egg, and that, as Dr. Allen Thomson remarks, "notwithstanding the extreme delicacy of some of the parts and the inequality of their density, every one of the sections may be made to present a distinct and true view both of the microscopic histological characters and of the larger morphological relations of the parts observed."

It may be useful here to refer to some of the discoveries of the embryologist. It is known that all animals are produced from cells, and that in all animals except the Protozoa the reproducing cells are ova. All ova undergo segmentation or division of the germinal portion, by a process analogous to that of fission in the Protozoa, first into two halves, an upper and a lower, which eventually give rise to two layers or membranes, an outer or ectoderm and an inner or endoderm. In the lowest animals produced from ova these two layers constitute the basis of the entire animal, and give rise to the animal and vegetative systems, or the external covering and the internal digestive cavity. But in the ova of animals of a higher order, a middle layer, or mesoderm, afterwards arises, which gives origin to the osseous, muscular and vascular systems. One of the earliest changes which supervene in the development of vertebrated animals is the formation of the rudimentary spine, the chorda dorsalis or notochord, which in the lowest form of fish, the Amphioxus or Lancelet, is persistent through life, that creature having neither skull nor vertebræ, but which, in the higher fish, gives rise to these bony structures of a simple form, and in the higher vertebrata to bones of more perfect development. Now it is a remarkable fact that this rudimentary spine, or notochord, was found by Kowalevsky in 1866, and since then by Kupfer and others, in the larvæ of the Ascidia, those marine, molluscoid animals having the form of a bottle with a double neck, inclosing the two external orifices of the body. They live either singly or in colonies, and are allied to the Polyzoa. They are, however, more highly organised, for they all possess a distinct heart in the form of a muscular tube without valves, which contracts rhythmically and propels the blood first in one direction (the respiratory) during a certain number of pulsations, and then, reversing its action, forces

it in the opposite direction, (the systemic;) so that the heart is alternately a venous and an arterial chamber. An analogy has been found in the relation of the notochord to other parts in the Ascidian larva with the same in the Amphioxus. Zoologists have thus been led to conceive the idea that the Ascidia and the Vertebrata may have had a common ancestral origin.

For an instructive lesson in embryology, I would recommend the study of the changes that take place during the development of the four-chambered heart of a warm-blooded animal, a bird, a mammal, or a man.

In its earliest form the heart is a simple tube which contracts rhythmically upon its contents. It soon becomes constricted in some parts and dilated in others, until three chambers are formed, analogous to the auricle, ventricle and aortic bulb of a fish. A septum now grows in the auricle, dividing it into two parts, the completion of which is retarded in the higher animals, owing to the conditions of fœtal life, but representing when complete the mature condition of the heart of the frog and other amphibia. Another septum now grows in the ventricle, and the various stages of its growth are represented in the permanent forms of the heart in various reptiles, until we arrive at the crocodile with the septum complete, the lowest animal that possesses a completely four-chambered heart.

Thus the science of embryology forms the key to the comprehension of many of the phenomena of organisation, and is the scientific basis of a natural classification of animals. Many abnormalities and congenital malformations can be understood only by reference to embryological development; and the genesis of species and the sequence of orders of animals as they have appeared during the geologic ages, receive a more rational interpretation when viewed by the light of organogenetic development and the relation of the various forms of the embryo to the adult.

It is impossible for me to refer to a tithe of the discoveries that have been made in natural science since the introduction of the achromatic microscope. The literature of the succeeding period is sufficient evidence of their number and value. Dr. Lankester, in 1860, referring to this literature, said: "It includes investigations with the microscope in every branch of natural science. It contains observations on the forms of crystals, plants and animals; it embraces the highest generalisations of physiological science, and includes countless investigations into the origin, forms, and modes of growth of organs and the ultimate parts of organs of both plants and animals. Altogether it forms an assemblage of facts and reasonings the most imposing that has ever been presented to the human mind in the same space of time in the whole history of science."

In the social aspect of the utility of the microscope, we are naturally reminded of its use in the detection of adulteration of food, scientific and religious imposture, and more serious crime; and of the assistance it has been in perfecting the knowledge of disease and the practice of medicine.

Most of you are aware of the part the microscope has taken in the detection of foreign and injurious substances in articles of diet. The various starches, which form an important part of our daily food, can be readily distinguished from each other by the microscope, although they have all the same chemical reactions. A cheap farina may thus be detected when mixed with a more expensive one. The cells of chicory can be distinguished from those of coffee, and the foreign ingredients of chicory itself, viz: acorns, carrots, and sawdust. The leaf adulterants of tea may also be recognised by their microscopical characters; and the various substances which can be detected by other means, such as gravitation in fluids, may also be recognised by the microscope. I will remind you of some recent legislation which has resulted from microscopical as well as other scientific inquiries of this kind. From 1851 to 1854 a series of articles on Adulteration appeared in the *Lancet*, the result of which was a parliamentary inquiry and the passing of the Adulteration of Food Act of 1860. An amended act was passed in 1872. These provided for the appointment of local analysts, with medical, chemical, and microscopical knowledge sufficient to cope with the mysteries of adulteration, which the resources of science and art had assisted to rear and foster. Inspectors were to be appointed to purchase suspected articles of food, drink, and drugs, and to prosecute the vendors upon the detection of adulteration, the penalty varying with the nature of the offence, from a fine not exceeding in any case fifty pounds, to imprisonment for six months with hard labour. In the days of Edward I., they had a summary method of dealing with misdemeanants, for according to the *Liber Albus*, it was provided that "if any default shall be found in the bread of a baker in the city, the first time let him be drawn upon a hurdle from the Guildhall to his own house through the great street where there be most people assembled, and through the great streets which are most dirty, with the faulty loaf hanging from his neck; if a second time he shall be found committing the same offence, let him be drawn from the Guildhall through the great street of Cheepe, in the manner aforesaid, to the pillory, and let him be put upon the pillory, and remain there at least one hour in the day; and the third time that such default be found, he shall be drawn, and the oven shall be pulled down, and the baker made to foreswear the trade in the city for ever."

In the detection of other forms of imposture the microscope is

not without its uses. In a former age the popular desire for religious relics, originating in the practice of assembling for worship at the tombs of saints, and erecting sanctuaries on such sites, rendered religious imposture an easy task. I need not refer to some of the curiosities of nature that were said to have been then exhibited, such as the "quill from the wing of the angel Gabriel." But we all know that *bone* and *blood* have not only been powerful agents, as saintly relics, in the maintenance of religious faith, but have also been the means of effecting imposture in both religion and science. I will therefore allude to the ways in which the microscope may detect imposture in these forms.

A transverse section of the shaft of a long bone of a mammal shows in its microscopical structure a number of circular areas, each area representing a section of a small cylindrical rod of bone, having a minute opening in its centre, called the Haversian canal, which is a branch of the large cavity of the entire bone, and, like it, is filled in the natural state with marrow and blood vessels. Round each Haversian canal are seen a series of irregular concentric circles, each circle having dark expansions upon it, representing cavities in the osseous tissue; each of these cavities or reservoirs, called lacunæ, has a number of extremely fine tubes, called canaliculi, branching from it and joining each other, and penetrating the minutest portions of the tissue. These canaliculi are too small for a blood corpuscle to enter, but the serum of the blood passes through them to nourish the bone. Professor Quekett first pointed out the difference in the size and arrangement of these lacunæ and canaliculi in different classes and orders of vertebrata. It has been found that the size of the animal bears no relation to the size of its lacunæ, but that the latter have a decided relation to the size of the blood corpuscles, which of course differ considerably in different classes and orders of vertebrated animals. Hence, as Dr. Carpenter remarks, "It is generally possible, by the microscopic examination of the merest fragment of a bone, to pronounce with great probability as to the *natural family* to which it has belonged"; and, therefore, some forms of imposture, either scientific or religious, may, within certain limits, be thus detected.

Dr. Sorby has shown how, with his micro-spectroscope, the $\frac{1}{1000}$ part of a grain of the colouring matter of a blood-clot is sufficient to reveal its character; and Dr. Day described in 1867, in the *Australian Medical Journal*, how, by the addition of tincture of guaiacum and "ozonised ether" to blood, a bright blue colour is produced, and this test has been found even more sensitive than that of the spectroscope, since it has been stated that $\frac{1}{16000}$ of a grain can be thus detected. It has also been found that tinting the corpuscles with aniline colours is a valuable

aid in distinguishing human blood from that of several domestic animals, viz., the horse, ox, pig, sheep, and goat. These tests, in combination with exact measurement of the corpuscles, are powerful aids in medico-legal investigations, in deciding the nature and source of a suspected stain, and may also be valuable in detecting some forms of imposture. That form of deception known to the medical profession as "malingering" has been revealed by the microscopical examination of the supposed sanguineous expectoration of a suspected patient. Many years ago, Dr. J. H. Bennett found in the sputum of a woman the blood of a bird, to the use of which she afterwards confessed.

You are all aware of the aid which the practice of medicine has derived from the microscope in the investigation of the nature of disease, and the diagnosis of its special forms. As the knowledge of the real relation between structure and function in health is due to microscopical research, so also is that between deranged structure and the symptoms of disease. I hope I may be excused for invading the province of our medical friends in order to call your attention to some of the latest researches that affect their art. It is not many years since Bacteria, those minute living organisms which appear to spring into existence in fluids containing organic matter undergoing putrefactive change, were regarded more in the light of microscopical curiosities, or as tests for an object-glass, than as having any scientific importance. Observers were, however, at work upon these and similar organisms, endeavouring to decide the question of the possibility of *spontaneous generation.* After a series of experiments on various nutritive fluids in flasks hermetically closed after boiling Dr. Bastian wrote a work to prove that he had discovered this form of generation. More careful experiments conducted by Pasteur, Tyndall, Dallinger, and others have shown this view to be untenable. Dr. Tyndall found that the germs themselves resisted the most prolonged boiling, but that if intervals of a few hours were allowed to elapse after each of several boilings of a single minute the fluid remained sterile. The living organisms could be killed only as they assumed the adult form, and as the germs were of different species, and in various conditions of activity, they required to be attacked separately. About the year 1838 Schwann was engaged in a similar investigation, when he discovered the vital nature of the changes in the cells of yeast, and that certain forms of fermentation and putrefaction were dependent upon the presence and increase of living organisms. The chemical theories of Liebig for a long time threw discredit upon the observations of Schwann, until Pasteur repeated them, and performed others, with the result of showing that each kind of fermentation that is not the result of purely chemical reactions

(vinous, acetic, lactic, butyric, &c.) is dependent upon the life of a specific organism or bacterium, microphyte, schizophyte, or microbe, as it is variously and generically called. Dr. Charles Cameron, in a paper read before the Philosophical Society of Glasgow, says, "The *Torula cerevisiæ* in the every day development of its life resolves sugar into alcohol; an organism very similar in appearance, but much smaller, produces lactic acid; a third, the *Microderma aceti*, oxidizes alcohol into acetic acid; a fourth, a lively vibrio, reduces fermentable matter to butyric acid with the liberation of hydrogen, which, when the matter fermenting contains phosphorus or sulphur, unites with them, and produces the unsavoury odours characteristic of putrefaction; another organism again, a little micrococcus, decomposes urea into ammonia, and hippuric acid into benzoic acid and glycocole; the transformation of tannic acid into gallic is the work of a sixth; the artificial conversion of ammoniacal waters into nitre appears to be due to the intervention of a seventh; and I might mention as many more instances of specific fermentation without exhausting the list of those of which the specific microbe has been demonstrated or studied." Thus the microscope has proved that these fermentative changes are physiological, and not merely chemical in their nature. These microbes can easily be destroyed by boiling, drying, exposure in some cases to oxygen, in others to carbonic acid, or by the application of weak antiseptic solutions. The germs of these microbes, however, survive all these processes. Nothing appears to kill them but the flame. The germs themselves are unassailable; the organisms to which they give rise are soon overcome. These organisms have been found in the bodies of man and the lower animals. The germs are doubtless taken in with the air we breathe, and the food we consume. Pasteur discovered in human septicœmia and pyœmia two specific organisms, in the former a vibrio, in the latter a micrococcus. The genius of Lister, who had heard of some of Pasteur's researches on fermentation, led him to originate the antiseptic treatment of wounds, which has been of untold benefit to humanity. Microbes have been found in the secretions of patients suffering from zymotic fevers, and recent researches lead us to believe that each infectious and contagious disease is accompanied by the presence of its specific microbes. They multiply at the expense of the patient, a struggle for existence goes on between the parasites and the vital cells of their host, and the result is death on the one side and victory on the other. We know that fevers have a tendency to run through certain courses, and the life-histories of these microbes may be regarded as affording some explanation of those courses.

Some forms of these micro-organisms have been found in the

blood and secretions of healthy animals, and it is probable that all animals, including man, are more or less infected with them, and that after death they multiply enormously, and carry on the work of putrefaction. M. Marix found that when yeast was injected in minute quantities into the veins of living animals it was almost harmless. In larger quantities it gave rise to symptoms analogous to those of typhoid fever, and in still larger quantities it was fatal. There must, however, be an essential difference between septic and pathogenic organisms, as Mr. Dowdeswell has remarked in a paper read to the Royal Microscopical Society, in which he states that in "Davaine's Septicœmia" in the rabbit he "found that in some cases one drop of infected blood contained upwards of 3,000 millions" of these organisms, and that this blood was "actively infective" in as small a quantity as the "one-millionth or the 100 millionth of a drop." Mr. Dowdeswell uses an objective, specially constructed by Messrs. Powell and Lealand for the investigation of these organisms. It is a $\frac{1}{20}$" homogeneous-immersion lens (N.A. 1·38), a fact worthy of consideration by those who regard wide apertures as useful only for resolving diatoms.

In Pasteur's experiments on the microbe of fowl cholera, a kind of micrococcus, he found that when a healthy fowl was inoculated with this microbe in a pure form, *i.e.*, separated from the fluids of the diseased fowl, and in a state of great activity and unaccompanied by an organism of another species, the fowl died; but by successive cultivations of the microbe in chicken broth, exposed to the action of oxygen, he found that he could produce a modified form of the microbe, which would impart the disease in a mitigated degree, from which the fowl recovered; and that a fowl so treated was constitutionally protected against subsequent attacks. He also found that the bacillus of anthrax or splenic fever in cattle and sheep could be treated in a similar manner. But there was this difference between the two microbes, that, whereas the micrococcus of fowl cholera reproduced itself by fission only and not by spores, the bacillus of splenic fever possessed both modes of reproduction. He found, however, that, by so regulating the temperature of the medium of cultivation as to make it either too high or too low for the microbe to carry on life with the greatest activity, he could compel it to reproduce itself by fission only; and that in this "attenuated form" it communicated the disease to inoculated sheep in such a modified degree as to give rise to local symptoms only, and a sheep so treated was protected, like the fowl, against attacks of the original and more virulent disease. The protective inoculation of sheep is now being carried on in France, and it is said with excellent results. This disease of sheep is communicable to the human subject, and is known as "wool-sorter's disease."

An important discovery in connection with microbes is that of

Dr. R. Koch, the medical officer of Public Health at Berlin, who has found that tuberculosis, or consumption, is dependent upon a bacillus. He found it in the sputa of consumptive patients, in tuberculous cavities, scrofulous glands, fungous joints, and the bones of tuberculous cattle; and animals inoculated with it became infected with the disease. His experiments have been confirmed by others. Dr. G. A. Heron, of London, has found, during six months practice amongst hospital patients, 62 cases of tuberculosis in which these bacilli were present, and he considers that the probable course of a case of this disease can be fairly prognosticated from the number of these organisms found in a microscopical field upon examination of the sputum.

Similar organisms have been found in diphtheria, hydrophobia, and other diseases, and their treatment by disinfectants has been made a subject of much research. The whole subject is yet in its infancy, and some statements of its phases should be received with caution. I think, however, I have said enough to show that the microscope has had a large share in the attainment of more exact knowledge of the nature of many of the most deadly diseases to which men and animals are subject, and that a field of inquiry has been opened which may be productive of as much good to humanity as any discovery in other departments of science. The disciples of Pasteur and Koch would, I suppose, scarcely look forward to the eradication of infectious diseases by the wholesale inoculation of the human race with attenuated microbes in their various forms. But may not these researches lead to the discovery of the rationale of the protective influence of inoculation and vaccination, which is at present unknown; and may not this discovery eventually lead to the finding of other modes of protection, more practicable and perhaps more secure?

I might refer to the aid the microscope has afforded the geologist in the determination of the real nature and mode of origin of the siliceous, calcareous and other rocks, by the discovery of the minute organic remains which have been found imbedded in them, and to the value of such discovery in the attainment of the more reasonable views now prevalent of the mode of formation of the earth; as well as to other subjects in which the microscope has advanced our knowledge of nature. I have, however, said enough to remind you of some of its uses in the field of natural science, and in the promotion of our well-being. In conclusion, I will remark that it is a benefit by no means small that we, as members of a Microscopical Society, are able to derive mutual assistance in the pursuit of some at least of the investigations I have indicated; and that, whether we are pursuing the study of the life-histories of the wonderful organisms found in those silent pools

> "Where rolls the Volvox sphere of green,
> And plastids move in Brownian dance,"

or tracing amid the simple forms of organic life some of those minute structures and marvellous functions which enable us to some extent to comprehend our own, we are led to realize a sense of the perfection and grandeur of the operations of nature; but of the true character of those operations how little we know, and how much must ever lie beyond the power of the human mind to discover!

ON MOUNTING INSECTS IN BALSAM WITHOUT PRESSURE.

By Herbert Chadwick.

FEW objects are more beautiful, or more instructive when properly mounted, than Insects. For many years it was customary to mount such specimens under pressure, a practice which in nearly all cases resulted in the destruction of the natural relation of the various parts; but of late years, the beautiful preparations sent out by Mr. Enoch and others, seem to have awakened microscopists to the desirability of mounting their specimens without pressure. Having made a series of experiments with this object in view, I have written the following notes on the methods employed, hoping that they may be useful to those who are engaged in the study of the anatomy of Insects.

Preparation I.—Soak the specimens in liquor potassæ, until they are transparent. Wash well in distilled water, using a pipette and camel hair pencil. Transfer to 50 pc. spirit, then to a small quantity of pure spirit, in a watch glass or soaking bottle, and allow them to stand for some hours. Then add oil of cloves, and allow the spirit to evaporate. By this method, the formation of air bubbles in the interior of the specimens may generally be avoided.

II.—Wash well in distilled water. Soak in pure spirit or alcohol for some days. Transfer to carbolic acid, until sufficiently transparent. Then transfer to oil of cloves, but many mounters do not consider this necessary. This method should be used in all cases where the integument is not too opaque to allow light to pass through it before treatment; and it is especially useful in the study of the muscles.

Mounting.—Take a clean 3 × 1 slip, having a sunk cell in its centre. Just inside the edge of the cell, equidistant from each other, cement three white glass beads A A A with hardened balsam. Put a small quantity of soft balsam in the centre of the cell, and gently warm it over a spirit lamp. Take the object, a

wasp's or blow fly's head for example, and place it upon the previously warmed balsam, arranging it in the required position. Now take a clean cover glass, the diameter of which should be a little less than that of the cell, and holding it between the points of a pair of forceps, place a large drop of balsam in its centre, and allow it to fall upon the object. The edge of the cover B should rest upon the three beads. If the quantity of balsam under the cover glass is not sufficient to fill up the whole of the space between it and the slide, a little more must be allowed to run in, and if the object has become displaced, it may be re-arranged by means of a fine blunt needle, introduced beneath the cover glass. A clip should be used during the last operations, but only to prevent displacement of the cover. The slide must now be put aside in a

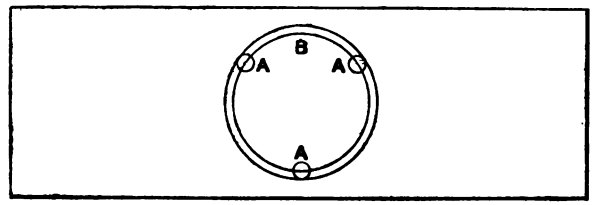


Fig. 34.

warm place, until the balsam is hard enough to allow the superfluous portion to be removed safely. Sufficient balsam should be left to form a sloping edge around the cover glass; and I always re-harden it for a few days after cleaning. Be sure that the balsam is quite hard before applying brown cement. The ease with which an object can be re-arranged, or a chance air bubble removed, without disturbing the cover glass, constitutes the chief advantage of using beads. A supply of different sizes should be kept, and the size used must be regulated by the thickness of the object. I always use pure balsam in collapsable tubes, which I strongly recommend, on account of the nicety with which the quantity of balsam required for mounting a slide can be regulated. The neck of the tube should be wiped with a clean cloth moistened with benzole before the screw-cap is re-placed, in order to prevent the possibility of a little balsam hardening in the screw, and so preventing the easy removal of the cap when next required.

PROFESSOR ABBE'S METHOD OF TESTING OBJECTIVES.

Extracted from the Journal of the Royal Microscopical Society.

THE late Dr. H. E. Fripp published, in 1877,* an account of Prof. Abbe's method of testing the optical quality of objectives, which he suggested might be usefully transferred to the pages of this journal. Various causes have hitherto prevented this, but we are now able to print it :—

In ordinary practice, microscope objectives, if tested at all by their possessors, are simply subjected to a comparison of performance with other lenses tried upon the same "test objects." The relative excellence of the image seen through each lens may, however, depend in a great part upon fortunate illumination, and not a little upon the experience and manipulative skill of the observer; besides which any trustworthy estimate of the performance of the lens under examination involves the consideration of a suitable test object, as well as the magnifying power and aperture of the objective. The structure of the test object should be well known, and the value of its "markings," if intended to indicate microscopical dimensions, should be accurately ascertained, care being taken that the minuteness of dimensions and general delicacy and perfection of the test object should be adapted to the power of the lens. A fairly correct estimate of the *relative* performance of lenses of moderate magnifying power may doubtless be thus made by a competent observer, but it is not possible from any comparisons of this kind to determine what may or ought to be the ultimate limit of optical performance, or whether any particular lens under examination has actually reached this limit.

Assuming the manipulation of the instrument and the illumination of the object to be as perfect as possible, and, further, that the test-object has been selected with due appreciation of the requirements of perfect optical delineation, a fair comparison can only be drawn between objectives of the same magnifying power and aperture. Which of two or more objectives gives the better image may be readily enough ascertained by such comparison, but the values thus ascertained hold good only for the particular class of objects examined. The best performance realized with a given magnifying power may possibly exceed expectation, yet still be below what might, and, therefore, ought to be obtained. On the other hand,

* Proc. Bristol Naturalists' Soc., ii. (1876-9) pp. 3-11 (2 figs.).

extravagant expectations may induce a belief in performances which cannot be realised. The employment of the test objects most in use is, moreover, calculated to lead to an entirely one-sided estimation of the actual working power of an objective, as, for example, when "resolving power" is estimated by its *extreme limits* rather than by its general efficiency; or "defining power," by extent of amplification rather than by clearness of outline. So that an observer is tempted to affirm that he can discern through his pet lens what no eye can see or lens show. This happens chiefly with the inexperienced beginner, but not unfrequently also with the advocate of extremely high powers, in whose mind separation of detail means analysis of structure, and optically void interspaces prove the non-existence of anything which he does not see.

As much time is often lost by frequent repetition of these competitive examinations (which after all lead to no better result than that the observer finds or fancies that one lens performs in his hands more or less satisfactorily than some other lens), it seems worth while to invite attention to a mode of testing which can be readily practised by any person, with a fair certainty of being able to form a really correct estimate of the working capacity of his instrument, measuring this by a standard of strict optical requirements. The advantage of substituting some such proceeding for the comparative trial of lens against lens, so long in vogue, can scarcely be disputed. For, although the best warrant of a well-constructed lens is the fair reputation of its maker, and the choice of an objective resolves itself for the most part into the selection of the particular make of one or other of the best accredited opticians, still, when the instrument is purchased, its possessor frequently becomes haunted by the desire to pit its performance against that of some neighbour's instrument, or to match the performances traditionally accepted in our handbooks. A short and easy method of testing an objective, not by comparison with others only, but by itself and on its own merits, affords not only the most direct and positive evidence of its qualities to those who are more concerned in proving their instruments than using them, but also yields to the genuine worker the satisfying conviction that his labour is not frustrated by faulty construction and performance of his instrument. It is, however, to be borne in mind that the microscopist, in any scrutiny of the quality of his lenses which he may attempt, has no other object in view than to acquire such insight into the optical conditions of good performance as will enable him to make the best use of his instrument, and acquire confidence in his interpretation of what he sees, as well as manipulative skill in examining microscopical objects. To the constructor and expert of optical science are left the severer investi-

gations of optical effects and causes, the difficulties of technical construction, the invention of new lens-combinations, and the numerous methods of testing their labours by delicate and exhaustive processes which require special aptitude, and lie entirely outside the sphere of the microscopist's usual work.

The mode of testing the optical power of an objective here described is that devised by Prof. Abbe, and explained in his "Beiträge zur Theorie des Mikroskops."*

The process is based on the following principle :—

In any combination of lenses of which an objective is composed, the geometrical delineations of the image of any object will be more or less complete and accurate according as the pencils of light coming from the object are more or less perfectly focussed on the conjugate focal plane of the objective. On this depend fine definition and exact distribution of light and shade. The accuracy of this focussing function will be best ascertained by analysing the course of isolated pencils directed upon different parts, or zones, of the aperture, and observing the union of several images in the focal plane. For this purpose it is necessary to bring under view the collective action of each part of the aperture, central or peripheral, while at the same time the image, which each part singly and separately forms, must be distinguishable and capable of comparison with the other images.

1. The illumination must, therefore, be so regulated that each zone of the aperture shall be represented by an image formed in the upper focal plane of the objective (*i.e.*, close behind or above its back lens), so that only one narrow track of light be allowed to pass for each zone, the tracts representing the several zones being kept, as far as possible, apart from each other.

Thus supposing the working surface of the front lens of an objective to be 1-4th in. in diameter the image of the pencil of light let in should not occupy a larger space than 1-16th in. When two pencils are employed, one of these should fall so as to extend from the centre of the field to 1-16th in. outside of it, and the other should fall on the opposite side of the axis, in the outer periphery of the field, leaving thus a space of 1-16th in. clear between its own inner margin and the centre of the field, where the objective images of the pencils occupy each a quarter of the diameter of the whole field.

If *three* pencils of light be employed, the first should fall so as to extend from the centre of the field to 1-25th in. outside of it; the second should occupy a zone on the opposite side of it, between the 1-25th and 1-12th in. (measured from the centre), and the third, the peripheral zone on the same side as the first.

* Arch. f. Mikr. Anat., ix. (1873) p. 413.

This arrangement places the pencils of light in their most sensitive position, and exposes most vividly any existing defect in correction, since the course of the rays is such that the pencils meet in the focal plane of the image at the widest possible angle. As many distinct images will be perceived as there may be zones or portions of the front face of the objective put in operation by separate pencils of light. If the objective be perfect all these images should blend *with one setting of focus* into a single clear colourless picture. Such a fusion of images into one is, however, prevented by faults of the image-forming process, which, so far as they arise from spherical aberration, do not allow this coincidence of several images from different parts of the field to take place at the same time, and so far as they arise from dispersion of colour, produce coloured fringes on the edges bordering the dark and light lines of the test object, and the edges of each separate image, as also of the corresponding coincident images in other parts of the field. It is to be borne in mind that the errors which are apparent with two or three such pencils of light must necessarily be multiplied when the *whole area* of an objective of faulty construction is in action.

2. *The means by which such isolated pencils can be obtained.*

If a special illuminating apparatus be employed, the condenser of Professor Abbe will be found very convenient, but almost any condenser of the kind (hemispherical lens) may be arranged for this purpose.

In the lower focal plane of the illuminating lens must be fitted diaphragms (easily made of blackened cardboard) pierced with two or three openings of such a size that their images, as formed by the objective, may occupy a fourth or sixth part of the diameter of the whole aperture (*i.e.*, of the field seen when looking down the tube of the instrument, after removing the ocular, upon the objective image). The required size of these holes, which depends, firstly on the focal length of the illuminating lens, and secondly, on the aperture of the objective, may be thus found. A test object being first sharply focussed, card diaphragms having holes of various sizes (two or three of the same size in each card) must be tried until one size is found, the image of which in the posterior focal plane of the objective shall be about a fourth to a sixth part of the diameter of the field of the objective. Holes having the dimensions thus experimentally found to give the required size of image must then be pierced in a card. If the condenser be fitted so as to revolve round the axis of the instrument, and also carry with it the ring or tube to which the card diaphragm is fixed, the pencils of light admitted through the holes will, by simply turning the condenser round, sweep the face of the lens in as many zones as there are holes. Supposing the condenser to be carried on a

rotating substage, no additional arrangement is required besides the diaphragm carrier. Thus, for example, if a Collins' condenser fitting in a rotating substage be used, all that is required is to substitute for the diaphragm which carries the stops and apertures as arranged by the maker, a diaphragm pierced with say three openings of 3-4ths in. diameter, in which circles of card may be dropped, the card being pierced with holes of different sizes according to the directions given above.

Another plan adopted by Dr. Fripp, and found very convenient in practice, is to mount a condensing lens (Professor Abbe's in this case) upon a short piece of tube which fits in the rotating substage. On opposite sides of this tube, and at a distance from the lower lens equal to the focal distance of the combinations, slits are cut out, through which a slip of stout cardboard can be passed across and below the lens. In the cardboard, holes of various sizes, and at various distances from each other, may be pierced according to pleasure. By simply passing the slip through the tube, the pencils of light admitted through the holes (which form images of these holes in the upper focal plane of the objective) are made to traverse the field of view, and by rotating the substage the whole face of the lens is swept and thus searched in any direction required.

When an instrument is not provided with a rotating substage it is sufficient to mount the condenser on a piece of tubing, which may slide in the setting always provided for the diaphragm on the under side of the stage. Card diaphrams for experiment may be placed upon the top of a third piece of tube (open at both ends) made to slide inside that which carries the condenser, and removable at will. By rotating this inner tube the pencils of light will be made to sweep round in the field, and thus permit each part of the central or peripheral zones to be brought into play.

3. *Test object.*

For this a prepared plate is required which shall present sharply defined black and white stripes, opaque and clear lines alternating at close intervals, and lying absolutely in the same plane, so that no deviation can occur in the course of pencils of light transmitted through it. A test plate sufficiently perfect for all practical purposes may be made by ruling groups of lines, coarse and fine, with the aid of a dividing machine on a metallic film of silver or gold of infinite thinness, and fixed by known methods on glass. Cover-glasses of various thicknesses, from 0·24 mm. to 0·09 mm. (accurately measured), are ruled on one surface thus coated with a film of metal, the groups of lines varying from 1-250th in.; the ruled side is then cemented with balsam on a polished glass slip, several such prepared glasses being cemented side by side on the same slip.

A perfectly corrected objective, tested with the test object, and by the mode of illumination above described, ought to show over the middle of the field a clearly defined image of the groups of lines under examination *without any alteration of focus*, and the coloured borders of the separate partial images should not show any other tints than a very narrow edging of pure green, rose, or violet of the secondary colours of a spectrum. Spherical aberration is revealed, when, with the best focussing, the clear lines appear as if immersed in the middle of a broader foggy streak, or when two images, more or less overlapping each other, merge on altering the focus, into one image, somewhat broader and more misty.

A short and ready method of testing approximately any objective is recommended by Professor Abbe, as it is applicable to all instruments without requiring any apparatus except the test object already described. This may be briefly explained as follows :—

First, focus the test plate with central illuminating rays, then withdraw the eye-piece, and turn aside the mirror so as to give the utmost obliquity of illumination, which the objective under trial will admit of. This will be best determined by looking down the tube of the Microscope whilst moving the mirror, and observing when the elliptic image of light reflected from it, reaches the peripheral edge of the field. As soon as this is done replace the eye-piece, and examine afresh the object plate *without altering the focus*. If the objective be perfectly corrected the groups of lines will be seen with as sharply defined edge as before, and the colours of the edges must, as before, appear only as those of the secondary spectrum in narrow and pure outline. Defective correction is revealed when this sharp definition fails, and the lines appear misty and overspread with colour, or when *an alteration of focus* is necessary to get better definition, and colours confuse the images.

A test image of this kind at once lays bare in all particulars the whole state of correction of the Microscope, it being of course assumed that the observer knows how to observe, and what to look for.

With the aid which theory offers to the diagnosis of the various aberrations, a comparison of the coloured borders of the separate partial images, and an examination of their lateral separation and their differences of level, as well in the middle as in the peripheral zones of the entire field, suffices for an accurate definition of the nature and amount of the several errors of correction, each of them appearing in its own primary form. Therewith we also see that which arises from aberration, properly so called (faults of focussing function), clearly separated from such imperfections or anomalies as spring from mere differences of amplification between unequally converged and unequally refracted rays; and, moreover, we eliminate completely all influence of the ocular on the quality of the image.

PHOTOMICROGRAPHY.

[A communication to the Manchester Photographic Society.]

By G. J. Johnson.

PHOTOMICROGRAPHY, or the process employed in photographing the magnified images of microscopic objects, has been practised in France, Germany, England, and America for some years to a more or less limited degree, but of late has received a great impulse from the facilities afforded by rapid gelatine dry plates for the practice of the art by ordinary artificial light. Under the wet collodion system the sensitiveness of the film was too slight for practical use with the lamp or gas, and few cared to encounter the somewhat precarious opportunity afforded in this climate by the happy conjunction of leisure and sunshine. Too often has the writer been victimised when, counting on a morning's holiday and having made all due preparation, the sun has unceremoniously withdrawn his face just as the sensitised plate was placed in the camera, and for weeks together has refused to reappear at an opportune moment.

The finest specimens of the art that I have seen were executed by Dr. Woodward, Surgeon-General of the United States Army, and residing at Washington, who has devoted much attention to the subject, and who evidently has been furnished by the Government with ample funds for carrying out his investigations. His apparatus is of the most complete description, an apartment being fitted up for the express purpose of taking photomicrographs, a heliostat provided, and lenses ground specially by Wales and others for accurate microscopic and photographic delineation. A report, fully illustrated, was published a few years ago by the American Government, containing the results of the labours of this scientist and his coadjutor, Dr. Curtis. Besides portraying such objects as diatoms, the nature of the delicate markings on which has been the subject of so much controversy in past years, these gentlemen have photographed numbers of pathological subjects, which, however, present great difficulties to the photographer on account of the want of penetration in microscopic lenses.

Mr. J. B. Dancer, the well-known Manchester optician, as long ago as 1840, produced photographs of microscopic objects, the image of a flea and other subjects being taken on silver plates.

The first photographic illustrations of microscopic objects published in this country appeared in the *Quarterly Journal of Microscopic Science* in 1853, Vol. I., since which period many works have been illustrated by means of these beautiful prints.

Besides Dr. Woodward, the names of Drs. R. L. Maddox, Aber-

crombie, Wilson, and Redmayne, and of Messrs. Wenham and Shadbolt, have for long been connected with a successful pursuit of the art. A specimen of the work of Dr. Maddox, of London, who photographed the objects delineated in the frontispiece of Dr. Beale's work on the microscope, now lies on the table. Mr. York has also just published a series of transparencies of micro objects suitable for lecture illustration.

I have also prints of diatoms from negatives taken by Fritsch and Müller, of Germany, and published by Williams and Norgate, 14, Henrietta-street, Covent Garden, London. One of the prints is a magnified representation of the set of diatoms so marvellously prepared by Möller, of Schleswig-Holstein, and known as the "typen-platte," or type plate. It contains 100 specimens of these beautiful organisms, which are now classed under the vegetable kingdom, and are found both in a fresh and fossil state over the whole world; for any stagnant pond, running ditch, or seaside pool will afford living examples for the microscopist.

I diverge for a moment from the immediate subject of my paper to describe these peculiar organisms on account of the beautiful skeletons they contain, which form favourite subjects for the photo-micrographer, the valves presenting a flat plane to the focussing-screen, and exhibiting wonderful variety in the sculptured markings on their faces. As a rule they consist of two plates of siliceous material covered with delicate patterns, the plates being held together by a band or hoop of similar material, the whole forming a sort of flat case—in some specimens like a round, shallow snuff-box, and containing protoplasm within. For microscopic purposes the specimens are boiled in acid, and the clean shells mounted dry or in balsam.

These examples of the German photographers, however, do not in any way exceed in beauty the work privately published by my late lamented friend, Dr. Redmayne, of Bolton, whose book of diatom photographs is also here for inspection.

Dr. Woodward, of Washington, has kindly sent me for the purpose of this paper a print of the diatom, *Surirella gemma*, as an example of high magnification and the resolution of difficult markings. Few microscopists, comparatively, succeed with their own instruments in resolving the lines of dots thereon, even with high powers, their resolution being much more difficult than that of the common test object *Pleurosigma angulatum*, to which I have before referred. This photograph was taken with a lens of $\frac{1}{25}$ focus, made by Powell and Lealand, and the magnification is 2,800 diameters, the dots, so plainly seen, each measuring about $\frac{1}{67000}$ of an inch; but I cannot say whether the negative was afterwards enlarged.

Those interested in this subject may find magnificent specimens

of Dr. Woodward's work in the libraries of the Royal Microscopical Society at King's College, and of the Microscopical Society of Liverpool.

Apparatus.—The apparatus employed need not necessarily be expensive. Any small microscope, with fine and coarse adjustments for focussing, and an ordinary quarter-plate camera arranged on a short base board, will serve for a beginner, and even the camera and microscope stand may be dispensed with by the use of a dark box, as described in the *English Mechanic* for February 2nd, 1883.

It is preferable, however, to have a base-board four feet long and eight inches wide, provided with a ledge of wood half-an-inch square on each side, between which a block or carriage may slide, and upon which a bellows camera can be fixed at such an altitude that the flange for the lens will admit the eye-piece end of the microscope, which must be placed in the horizontal position. To allow of a wide field it will be well to have the body or tube cut off about an inch from the nose, and a screw collar arranged to allow of replacement of the tube when it is desired to use the instrument in the ordinary way, or to photograph with the addition of the eye-piece. A short cardboard tube fitting in to the lens flange of the camera will allow of a taper velvet collar two or three inches long being glued thereto, which will serve to keep out the light and yet allow free movement of the object-glass for focussing.

The bellows should possess the greatest latitude of expansion, allowing a variation of length of focus from ten inches to thirty-six inches. The interior of the microscope body should be lined with black velvet to prevent flare on the plate from reflection. When the camera is extended to the full limit, a piece of looking-glass held in the left hand at a suitable angle opposite the ground glass screen will enable the operator with his right hand to focus roughly with the coarse adjustment screw. For accurate focussing a rod passes under the camera, having at one end a knob as a handle, and at the other extremity a pulley one inch in diameter provided with a V groove, in which runs an endless cord working the button of the fine adjustment, also grooved. The rod and pulley should work smoothly to avoid uneven strain on the arm carrying the objective, and the fine adjustment should run sweetly and answer immediately to the least turn of the rod. A mechanical stage with rectilinear motions for carrying the object to be photographed is very convenient, but not essential. The stage plate should, however, be furnished with levelling screws at the corners for bringing all parts of the picture into a flat plane. Both of these appliances are to be seen on the instrument before you.

On the shaft of the fine adjustment screw a short split brass tube half-an-inch long is made to slide stiffly, to which a stout wire pointer three or four inches long is soldered. A semicircle of

cardboard, having its centre coincident with the axis of the fine adjustment screw, is placed behind the pointer, and marked in its circumference with degrees. The split tube allows of the entire revolution of the adjustment screw, whilst the pointer acts as an index through 90° of arc, and records with exactness any slight alteration in focus. The necessity for this will be hereafter explained.

As correct focussing is a most essential point in photomicrography, the finest ground glass is inadequate for viewing the image for final adjustment. The screen is therefore removed, and a lens of short focus, mounted in the middle of a light lath, two inches wide and fourteen inches long, is so adjusted in a short tube that its focus is coincident with the plane of the sensitive film when the

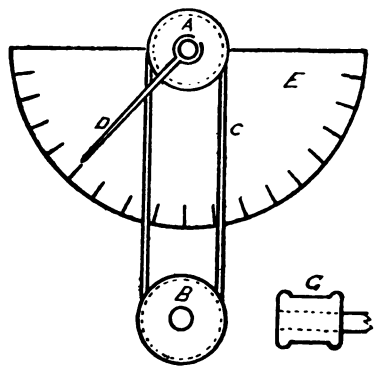


Fig. 35.

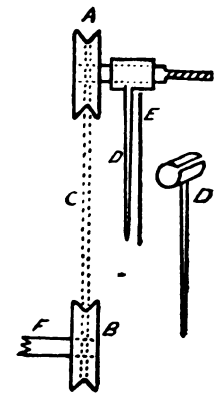


Fig. 36.

lath is held against the back of the camera. This operates as an eye-piece, and the adjusting rod is turned till the picture appears in sharp outline.

At the side of the base-board a scale of inches is marked, measuring from the object carrier, for recording the length of focus employed. Scales of diameter under the respective object-glasses can also be added, showing at a glance the magnification obtained. Thus, at thirty-six inches, it is definitely seen on this instrument that the two-inch objective gives twenty-one diameters.

The chief difficulties to be surmounted by the novice occur under the following heads:—1. Non-coincidence of actinic and visual foci of lenses. 2. Even illumination. 3. Exposure. 4. Selection of suitable objects for photography.

ACTINIC AND VISUAL FOCI.—In photographic lenses by good

makers great pains are taken to make the actinic and visual rays meet in the same point; but as microscopic lenses as a rule are constructed solely for giving the best definition to the human eye, a different formula is adopted for the curves of the glasses. For the sake of your junior members, some of whom may be imperfectly acquainted with optics, you will, perhaps, grant me a short indulgence while I explain the principle of achromatism. [Diagrams were thrown upon the screen illustrative of the construction of achromatic lenses and the over-correction of microscopic objectives.]

As it is generally accepted that the best definition is obtained in photomicrography without the use of the eyepiece, you will at once see the necessity for allowing readily for this discrepancy between the visual and actinic foci. In the instrument before you I have determined by experiment that, when a two-inch object-glass by Baker is employed, the screen being thirty-seven inches distant from the object-screen which has been visually focussed, the objective must be withdrawn $\frac{15}{2000}$ inches, or the rod turned till the pointer previously placed at zero passes through 15° to the right (at half the focal distance $7\frac{1}{2}$° must be allowed). The chemical rays will then make a sharp picture on the film, whilst the outline appears blurred to ordinary vision. In the more delicate corrections required by the higher powers recourse may be had to extension of the bellows instead of altering the fine adjustment screw. The allowance required for each objective can readily be ascertained by placing an ordinary micrometer scale ruled to $\frac{1}{100}$ths and $\frac{1}{1000}$ths inch on the stage of the microscope at an angle of 10° to 15°, so that each line has a varying focal point. On the screen is a photograph of such a scale taken at thirty-seven inches by the two-inch lens, the visual focus having been adjusted at the first line of the thousandths, and the best photographic definition coming out about the fifth or sixth line of the hundredths. The difference in the visual foci of these two lines was represented by 15° on the scale, which was readily found by viewing the scale through the eyepiece and swinging the index between the two focal points. Instead of the micrometer scale an object not pressed too flat—such as a fly which has delicate hairs lying in different planes—may be employed in a like manner.

If a specially sharp picture be required of some difficult object, trial plates should be taken with determinate variations in the length of the bellows, either by cutting a dry plate into slips—which should be numbered and exposed separately—or a diaphragm can be placed immediately behind the focussing-screen, having a revolving disc three inches in diameter fixed in the centre, a quadrant being cut out of the same to allow of successive exposures, the disc being revolved and the shutter lowered between

each variation of the bellows. Four results will thus be exhibited on the same plate.

No tables can be given for the actinic allowance required by the various powers. A one-inch by Dancer, lent by a friend, was found to produce sharp pictures without any such allowance, whilst another by Swift required 2° on my scale. Powers above one-quarter of an inch seldom require compensation, and some of the *photographic* lenses of English make, when stopped down, perform admirably on large objects of a half or one inch in diameter. Many of the pictures to be seen to-night were produced by Dallmeyer's stereoscopic lens, kindly lent by Mr. J. Pollitt. The tyro is recommended to ascertain definitely, once for all, the exact allowance required for each lens, and to keep a careful record of the same.

In order to produce satisfactory negatives no pains should be spared to obtain a flat and even picture, by levelling the object by means of the set screws referred to. I have seen many otherwise commendable photographs utterly spoiled by one-half of the picture being out of focus.

Illumination.—The most preferable source of light, as far as my experience goes, is the sun, but the electric arc, lime-light, gas, and paraffine lamps have all been used. Now that sensitive dry plates are within the reach of all the paraffine lamp is usually employed, either naked or with a bull's-eye condenser interposed. If the latter be employed difficulty is often experienced in obtaining even illumination all over the field, the thickness of the glass breaking up the rays into prismatic colours. Mr. Dancer recommends a double combination quarter-plate lens used as a condenser, an image of the lamp flame being formed thereby a little behind the object, so that the rays just cross before arrival. A disc of light should be produced which amply covers the size of the object. It will be found convenient to ascertain the correctness of the illumination by placing a slip of white writing paper on the object-slide, and observing whether the image of the flame fully envelopes the field. In using the higher powers, when it becomes necessary to obtain more intense light upon a small space the paraffine flame may be placed edgewise. With a good lamp powers up to one-fifteenth of an inch may be employed with dry plates. For low magnifications ordinary daylight from a white cloud will suffice. In using sunlight it is sometimes necessary to interpose a glass cell containing a solution of common alum to arrest the heat rays, otherwise the object or the lens may be injured. With naked sunlight, also, diffraction and interference lines are apt to appear around the image, when a plate of ground glass should be fixed an inch or so behind the object to soften the light. Dr. Woodward, in using very high powers, has sometimes found it imperative to make use of

monochromatic light. This can be obtained by causing the sun's rays to pass through a solution of sulphate of copper to which is added strong ammonia.

In photographing the delicate markings of some diatoms the light must impinge on these transparent objects at a considerable angle, or the direct flood of rays will drown all detail. In photographing the proboscis of a blow-fly I found a superabundance of light fatal to the fine delineation of the false *trachea*. With objects difficult of resolution the ordinary achromatic condenser of the microscope is often employed.

Definition.—In the lower powers definition is rendered much more perfect by the introduction of a stop behind the back lens. For instance: in portraying a section of the stem of the dog rose, a stop a quarter of an inch in diameter materially improved the definition of the delicate cells, and in many histological specimens, where great penetration is required, the tissues being comparatively thick, a reduction of the aperture of the lens is imperative. Stops of cardboard or turned wood may be employed, or Davis's iris aperture shutter, which gives all variations in size from a pin point upwards.

Objects.—All microscopical objects are not equally suitable, on account of either colour or thickness. Tissues stained light blue or purple give faint images, while dense brown objects will not allow light to penetrate the detail. Preparations of insects (such as fleas, which make capital subjects for the beginner) should have lain in the potash solution or turpentine a sufficient time to render the body semi-transparent. Sections of woods, if cut thin and stained a suitable colour, make good pictures. Sections of lung, if thin, give good results, but many anatomical preparations of soft tissues are too thick to allow of perfect focussing with the higher powers. A beautiful section of the retina of the human eye which I possess, although most interesting when viewed in the ordinary microscope, is quite unfit for the camera. Diatoms which present a flat surface, like *arachnoidiscus*, are most suitable, but require careful levelling on the stage.

Exposure.—No fixed rule can be given for exposure, which varies with the light, lenses, and length of focus employed, but much trouble will be avoided by the operator if a standard light be used, and a careful record kept of the results of exposures by means of a register, such as that which lies on the table. With Swan's "ten times" dry plates a small microscopic paraffine lamp without condenser, fixed seven inches from the object, give a good picture in one minute, with a two-inch lens full aperture, and the bellows extended to thirty inches.

As a rule, amateurs over-expose their plates, and produce a weak, thin negative. The movable disc before referred to affords an

easy method of testing the time of exposure, four tests being obtained on one plate. Another method is to partially raise the shutter at intervals, noting the time for each exposure; then to cut the plate down the middle with a diamond, and develope one half two or three minutes longer than the other. Six variations on the exposures can thus be seen, and the utmost novice will be able to discern "which way the cat jumps."

Photographic Process.—If sunlight were always at command I should prefer the wet collodion process, on account of the readiness and rapidity with which trial plates can be developed and examined. Every object differs so much in density or size that the time of exposure is ever varying, and carefully-repeated experiments are necessary. I have heard it stated that Dr. Maddox thought he did well to secure one good negative a day.

Development.—For readiness of application at rare intervals of leisure I have preferred the ferrous oxalalate developer for dry plates, and all my gelatine negatives have been executed so far by this process; but it is doubtful whether this method allows of so much latitude in nursing up the contrasts in a negative of a very transparent object, as is afforded by the pyro. developer. I have also intensified, where requisite, with the saturated solution of bichloride of mercury, and, after well washing, steeping in the solution of ammonia. The solution of mercury may be kept in stock, and used over and over again.

Magnification.—The greater the disparity between the distance of the front lens from the object and the distance of the lens from the sensitive plate the less chance is there of securing penetration or deep focus. Therefore, if large prints are required, better results will follow from employing a low power and taking a small picture, afterwards enlarging from the negative. Quarter-plates will suffice in most instances for this class of work, and those members who have seen Professor Piazzi Smyth's negatives of the Pyramids, only one inch square, and enlarged three diameters by Mr. Pollitt, will be aware how well they bear further magnification on the lantern screen.

The highest resolution I have heard of or seen by photomicrography is that by Dr. Woodward with Zeiss's oil immersion lens one-twelfth of an inch, on the diatom *Amphipleura pellucida*, where the striæ, which in nature count about 100,000 to the inch, are plainly delineated on the print; and Mr. Crisp, the secretary of the R.M.S., tells me the lines have never been so clearly shown by ordinary vision. The nineteenth band of Nobert's test-plate of finely-ruled lines on glass, containing about 100,000 to the inch, was also resolved by this unapproached operator with Tolles' one-eighteenth of an inch immersion lens.

From certain late researches of Professor Abbe the theory is

established that when we are near the limits of "resolution," the superiority of photographic vision, so to speak, over that of ordinary microscopic vision is as five to four, all other things being equal; but it must be remembered that ordinary microscopic powers are constructed for vision and not for chemical portraiture.

The various magnifications obtained by the several powers are set down by Mr. Davis as follows. At thirty-six inches :—

4 in.	× 12	$\frac{1}{4}$ in.	× 173
2 „	„ „ 21	$\frac{1}{8}$ „	„ „ 360
1 „	„ „ 37	$\frac{1}{16}$ „	„ „ 530
$\frac{1}{2}$ „	„ „ 80		

Bibliography.—Dr. Beale's *How to Work with the Microscope; Monthly Microscopical Journal:* report by Dr. Woodward, vol. vi., p. 169; *Quarterly Journal of the Microscopical Society*, vol. i., 1853; *Northern Microscopist:* article by G. E. Davis, April, 1881; *Science Gossip*, 1876: article by F. H. Powell; *The British Journal of Photography*, January 26 and February 2, 1883; *English Mechanic*, February 2, 1883.

In conclusion: before we show upon the screen some of the combined work of Mr. Pollitt and myself, allow me to admit that in the presence of such an important Society I feel I have much more to learn than to teach, and I invite your candid criticism of any statement I have made with a view to furthering the development of a most interesting branch of your art, which for some years has been a source of much interest to myself, and is evidently about to become of great educational value.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

SUBSCRIPTIONS FOR 1883. The current year's subscriptions became due in January last. Will those subscribers who have not remitted, kindly do so at once?

BACILLUS TUBERCULOSIS.—Mr. Coppock, in sending out his prepared stains, issues the following directions for staining and preparing sputum :—

"Obtain fresh sputum, and spread a small portion upon a thin cover glass, dry in the air, place a few drops of the *Magenta and Aniline* Stain in a watch glass and float the cover glass, sputum

downwards, upon its surface for thirty minutes, then wash in dilute Nitric Acid (1 to 3) until all perceptible colour is removed. Wash in distilled water to remove all trace of acid. Float again, sputum downwards, upon a little of the *Chrysoidine* stain, wash in distilled water, then immerse in absolute alcohol to remove all trace of water.

The preparation is now ready for mounting permanently, and a drop of liquid Canada Balsam may be placed upon the cover glass and then laid carefully upon a glass (3 by 1-in.) slip, and the spirit in the Balsam allowed to evaporate, or if wanted for immediate examination a little shellac may be run round the edges of the cover glass."

MANCHESTER MICROSCOPICAL SOCIETY.—The annual meeting of the Manchester Microscopical Society was held on Thursday, Feb. 22nd, at the Mechanics' Institution, Princess-street, under the presidency of Mr. William Blackburn. The report of the committee for the past year, which was read by Mr. C. L. Cook (the honorary secretary), stated that the members of the Society now number 214. The ordinary meetings had been well attended, and papers regularly read. The mounting-class and the rambles had been more than usually successful. After the officers and council for the ensuing year had been elected, Mr. Blackburn delivered an address, in which he stated that he had been very unwillingly pressed into the service. It had been the unanimous wish of the Society that Mr. Davis, well-known as the editor of THE MICROSCOPICAL NEWS, should have been president for the year, but Mr. Davis, in consequence of his numerous engagements, did not see his way to add to his responsibilities, and, therefore, under these circumstances, he felt bound to accede to the wishes of those (especially Mr. Davis himself) who were desirous that he should occupy the chair for the year.

Mr. Blackburn, in his address (to be found as this month's leader) spoke of the influence of microscopical research on the progress of natural science and on our well-being, and concluded with an epitome of the recent researches on the septic and pathogenic organisms, and the rational explanation they afford of the sources and communicability of infectious and contagious diseases.

CARLISLE MICROSCOPICAL SOCIETY.—A meeting of members of the Carlisle Microscopical Society was held in the Young Men's Hall, Fisher-street, on Friday night, when a paper was read by Dr. Hall, vice-president, on "*Trichina spiralis.*" Mr. W. Brown was to have prepared the paper, but through the pressure of his professional duties was unable to do so, and the subject was kindly taken up by Dr. Hall. In speaking of Trichinosis he said:—The disease could be clearly made out after death in cutting up the carcase;

for in a very large percentage of the cases of trichinoid pork, the knife in passing through the flesh would be almost sure to encounter gritty particles, which consist chiefly of phosphate of lime and are formed round the cysts of the trichinæ. Mr. Hall further observed that speckled hams bearing the appearance of trichinous disease were to be found, and he related an instance in which a large dealer had been threatened with an action for selling trichinous ham, the appearance of which was in reality due to the peculiar formation of the mildew or fungus arising through the hams being kept in a damp place. Officers who had undergone examinations in the use of the microscope were appointed on the Continent to examine all pork before its sale. They were rewarded for every specimen of trichina they found. Sometimes vinegar eels were mistaken for the mature sexual trichina. Mr. Hall exhibited several specimens of the disease both in the human subject and in pork; also various illustrations.

THE GERM THEORY OF PHTHISIS VERIFIED.—We have received a brochure of 94 pages, bearing this title; it abounds with figures and statistics, and will doubtless prove valuable to the advanced ranks of the medical profession. Its author is W. Thomson, F.R.C.S.; the Publishers are Messrs. Sands and McDougall, of Melbourne.

HEMIDINIUM NASUTUM.—Mr. Bolton has been sending this little organism from his studio during this month. It was found in a ditch in Sutton Park, amongst decaying leaves.

THE WASP AND HONEY BEE.—At the usual fortnightly meeting of the Manchester Field Naturalists Society, a lecture was delivered by Mr. J. F. Robinson, of the Owens College museum, "On the Anatomy and Economy of the Honey Bee." The *Manchester City News* makes Mr. Robinson to say, "the wasp can sting any number of times without sustaining any injury, while the bee's sting being barbed at the tip, when once it is inserted in the skin cannot be withdrawn without causing the death of the insect."

We rather think that if our readers will examine the sting of the wasp, they will find it is "barbed at the tip" also.—ED.

ÆCIDIUM OR PUCCINIA.—In 1881 Mr. Plowright, with an unbiassed mind, set to work to find out whether there was any connection between Æcidium and Puccinia. His experiments consisted in infecting young wheat plants with the spores of Æcidia and comparing them with similar uninfected plants. No definite conclusion was arrived at, as both infected and uninfected plants developed forms of Uredo.

In the following year (1882) Mr. Plowright succeeded in cultivating Æcidium from *Puccinia graminis*, and from the spores of

these Æcidia he produced Uredines as in 1881, but his method of isolating the trial plants was more perfect, and no Uredines were developed on uninfected specimens. Other experiments were made with various forms of Uredo, all tending to the same result, and Mr. Plowright is now perfectly convinced that Æcidium and Puccinia are different forms of the same fungus.

MANCHESTER CRYPTOGAMIC SOCIETY. — The usual monthly meeting was held in the Old Town Hall, Dr. B. Carrington, F.R.S.E., in the chair. Mr. W. H. Pearson exhibited a specimen copy of the Fasciculus III. of the *Hepaticæ Britannicæ Exiccatæ*, containing many new and rare species, amongst which were noticed *Marsupella Stableri*, *Cephalozia Francisci*, *C. æraria*, *C. Turneri*, *Bazzania trilobata*, *Lepidozia Pearsoni*.

Dr. J. B. Wood sent specimens of the two species of *Buxbaumia*, *B. indusiata* and *B. aphylla*, both gathered by himself in the same locality during his visit to the Vosges, Aug. 1872. The *B. indusiata* growing on rotten wood—the *B. aphylla* on the ground. He also sent specimens of *Dichelyma capillaceum* in fruit, from Norway and North America.

POSTAL MICROSCOPICAL SOCIETY.—The Journal of this Society for March commences the second volume. Its price, we notice, has been raised to eighteenpence, which is not too dear for an 8vo 64 page journal, illustrated with 6 plates. Respecting the character of these plates, we must candidly confess we do not like them,—would it not be better to give only 2 plates in each number and have them done well, rather than 6 of a not altogether satisfactory character? We notice the numbering of the plates has been continued from vol. 1. This is a mistake, each volume should be complete in itself.

OTHER JOURNALS.—While on this subject may we venture an appeal to the Council of the Royal Microscopical Society? The first volume is dated 1878 and called Vol. I.; the 1879 vol. is inscribed Vol. II., and 1880 Vol. III. Then in 1881 the title page bears the inscription Series II., Vol. I., and the next year Series II., Vol. II., the 1883 volume will probably be Series II., Vol. III., so that during the past six years we shall have had two inscribed Vol. I., two Vol. II., and two Vol. III. We hope these remarks will not encourage any one to prepare Series III., Vol. I. A further suggestion may be thrown out to the effect that if the Journal grows any thicker it would be well to divide it into half-yearly volumes.

GELATINE AND ALBUMEN PLATES.—Mr. J. T. Chapman, of Manchester, is now supplying these plates for the production of transparencies for the lantern. They are about as sensitive as wet plates, and produce exceedingly good pictures when developed with ferrous oxalate.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 29. MAY. 1883.

THE ORAL ORGANS OF THE GAD-FLY.

By J. B. PETTIGREW.

IN preparing a former paper on the Gnat and Mosquito, the interest excited by the examination of the complex oral organs of these insects led me to carry the investigation a little further, and to enquire how far they would bear comparison with those of other blood-sucking Diptera.

The Gad-fly naturally presented itself as very convenient for the purpose, on account both of the size and of the clear definition of its setæ, which render them readily available for microscopical purposes.

Without attempting to point out the differences of structural detail which distinguish the oral apparatus of the various species of the family Tabanidæ, I propose to give a short description of them as presented in the common grey Gad-fly—*Hæmatopota Pluvialis*. Fig. 37 is a drawing done under the camera of the organs of this insect as displayed in a prepared slide and amplified to twenty-one diameters.

We have here a good example of a suctorial mouth, furnished with a full complement of organs, each of which is complete in itself, and is adapted to a special purpose. It will be noticed that the setae are of four distinct kinds. They are all composed of clear amber-coloured chitine, are set closely together, and possess considerable strength and rigidity. The fifth organ, however, the *labium*, is remarkable for its extreme flexibility, rendering it, as we shall see later, capable of traversing a comparatively extensive area. Viewed together, these form a proboscis-like, downward prolongation of the head in a direction at right angles to the axis of the thorax, with a thickened, somewhat bulbous extremity, caused by the position and shape of the *labium;* the setae themselves, when at rest, forming a slender body tapering to a blunt point and resting upon the cavity of the *labium*. Commencing anteriorly, the organ

which first presents itself is the *labrum*, the homologue of the upper lip of mandibulate insects, marked lbr. in figure. This is a straight, trough-like organ, rather longer than the head of the insect —hollow throughout, and having the slides turned over along their margin so as partly to enclose the interior. The base is considerably broader than that of the older setae, but like them the labrum tapers gradually. It terminates in a blunt point, closing in the end. This blunt tip, when examined under one of the higher powers, presents a peculiar structure, which at once suggests the presence of a sense organ. On each side of the upper part of a slightly rounded surface are placed two discoidal plates, studded with papillæ, and having below them a convex body also papillated, but with much more minute papillæ. What is the special function of

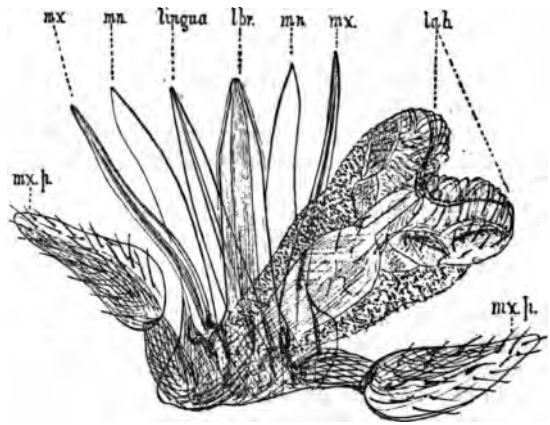


Fig. 37.

these bodies I have been unable to find out; but, taking into consideration their position and structure, it seems very probably that it is sensorial. Running along the middle of each side of the labrum from base to tip is an extremely delicate, flattened ridge, minutely fringed at the edge.

The hollow structure of the labrum naturally fits it to be the sheath of the other setæ.

Lying immediately below and on each side of the labrum are the two *mandibles* (mn. Fig. 37). These are long, broad, flattened blades, tapering to a point which is very slightly curved. One of these enlarged to 262 diameters is shown as Fig. 39. The outer edge is seen to be cleanly incisive, and from this the blade appears to become somewhat thicker as the inner edge is approached. This, throughout almost its entire length, is armed with extremely small,

regularly set, saw-like teeth, decreasing slightly in size from the tip towards the base. It is almost impossible to represent these teeth exactly in a drawing, so small are they. According to Gosse, twelve of them are cut in a length of one ten-thousandth part of an inch.

Referring to Fig. 37 again, on each side of the mandibles are found the *maxillæ* (mx.) In structure, these are rather more complex than the former. Of about the same length, they are much narrower, and in place of being flattened, they are thickened into a bayonet-like form, triangular in section, of which the base is widened out. Like a bayonet, too, they bend a little backwards

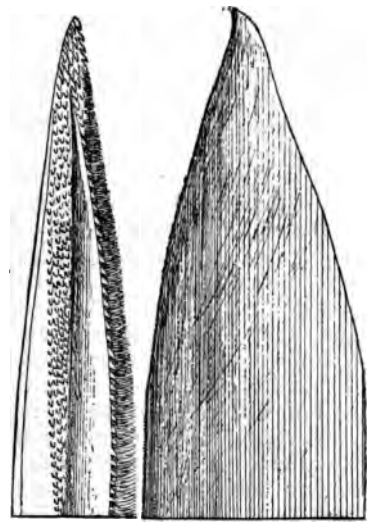


Fig. 38. Fig. 39.

near the point, and present a blunter termination than is found in the mandibles. The maxillæ are also armed with a formidable array of teeth, the arrangement of which is peculiar and rather difficult to describe. Reference to Fig. 38 will here perhaps be of some assistance.

Of the three sides of the maxilla, one is broader than the other two. Commencing at the dilated basal part, this side is found to be deeply channeled, or grooved, quite up to its edges. The groove gradually narrows and becomes less deep in the direction of the tip, leaving thus, on each side, a marginal surface gradually broadening until the groove disappears near the tip. Here there are closely set a number of strong, recurved teeth carried to the extreme point

and edges; at the tip hooked, but lozenge-shaped, where they are continued along the margin in a broadening band which is, however, reduced to a single row of hooked teeth, terminating about the middle of the maxilla. This band does not occupy the entire marginal surface on this side, although it closely borders the edge of the groove. On the other, and, as shown in the Figure on the margin, the teeth assume a longer and more acutely pointed shape in a single row carried along the edge of the grooved hollow to a point rather nearer the head than the termination of the opposite row. Interspersed amongst the teeth on the outer band are numerous short bristly hairs. These merge in a dense, hair-like fringe, carried down the maxilla almost to its base, being longest and finest about the middle third of its length. The Figure is a drawing of the upper third of the maxilla. We have now to consider the remaining seta, the *lingua*, *ligula* or tongue (*lingua*, Fig. 37) described by Gosse as the *labium*, although Burmeister clearly shows that this term is rarely only applicable to the proboscis of the suctorial mouth.

And here I may remark that the drawings, useful as they may be for purposes of illustration, must not be considered as at all a faithful representation of the various organs as they naturally appear. Being taken from a prepared slide, they are necessarily imperfect as regards the true relative position of the parts, and also, to a great extent, in respect of their shape. The mandibles and maxillæ, from their structure and shape, may be little altered, but the hollow labrum and *lingua* and the soft *labium* are necessarily flattened and so distorted. I mention this because, from the appearance of the *lingua*, the organ now under consideration, the mistake might easily be made of assuming for it a distinctly tabular structure. Such, however, is not the case. It may rather be described as resembling in form a thin pointed pea-pod, open to the end along one margin but closed on the opposite side. In the *lingua*, this longitudinal opening is opposite to, and so far corresponds with, that of the labrum already described. That it is used as a suctorial tube may readily be believed; but there can be no doubt that it also serves as an inner sheath for the mandibles and maxillæ, the five together then fitting into the cavity of the labrum. In structure, the *lingua* presents no special characteristics, being throughout composed of hard, clear chitine, and having the two free edges clothed with a delicate fringe, similar in character to, but much finer than, that of the maxillæ.

In passing, a word should be given to the maxillary palpi, one of which is attached to the base of each maxilla. They are two-jointed, the second joint club-shaped, and much dilated at its basal end.

There remains to be noticed the *labium* or proboscis, correspond-

ing to the lower, as the labrum does to the upper lip of a mandibulate insect.

In general character and structure this organ resembles the well-known proboscis of the Blow-fly, and the comparison will perhaps serve better than an elaborate description. It is, however, relatively longer in the stalk, is not bent, but straight, and the terminal divided knob is somewhat differently placed. For some distance from the base it is supported by a chitinous structure analogous to the *mentum*, or chin, which has on each side a membranous flap continued and meeting further on, and at length forming the exceedingly delicate membrane upon which the radiating system of suctorial semi-tubes is arranged. The outer surface of the membrane is thickly covered throughout, with the exception of the region of the tubes, with peculiar very short hairs arranged in groups, *not singly*, as is usual. That is to say, each minute hair, in place of being separately imbedded in the membrane, is grouped with several others on a common base which seems to project slightly itself above the surface. Near the tip again, are placed a number of strong bristles with well defined basal sockets.

The labium, in fact, partly encloses the other organs when at rest, they lying along its inner surface and between the terminal lips of the knob. According to Burmeister, the terminal lips are in reality differentiated labial palpi.

We have here an apparatus well adapted in all its parts to the purpose; first of all, of reaching the seat of the fluid nutriment necessary to the insect, and then of gathering it up and conveying it to the digestive tract. It should be stated, however, that only the female Gad-fly possesses the full complement of organs described. The male is destitute of mandibles, and I think I am right in saying, of maxillæ also. Far from exhibiting the blood-thirsty instincts of the female, he is of a quiet, retiring disposition, preferring the shade of woods, and for food the juices of flowers.

As to the special function of the different organs, I am unable to say much. Their strength, form, and size enable them to penetrate the skin of most, if not all, British animals with comparative ease. The mandibles are probably first brought into play to make an opening into which the barbed maxillæ can then be plunged to enlarge and tear open the wound. The labrum and lingua seem to enter with the rest, and either by the lingua alone, or by the combined organs used as a tube, the blood is imbibed. The wound caused in this operation is sufficiently severe, but the formidable armature of the setæ fully accounts for the pain and subsequent irritation which accompany the bite.

A question here arises as to the function of the labium, if the lingua, or the other organs combined, must be regarded as suctorial. That it is itself capable of fulfilling a similar purpose cannot be

doubted. Its flexibility is such as to give it a greater range than any of the other organs, allowing it either to operate on a small point or to flatten itself out upon a comparatively large surface.

It is not unlikely that the labium is used, as it is by the male, for gathering up the secretions of flowers, but a possible explanation of its use along with the other organs has occurred to me which is perhaps worth mentioning. The bite of the Gad-fly is so acutely painful that the attention of any animal attacked by it is at once drawn to the punctured spot, and in the majority of cases the insect must be almost immediately dislodged. When it returns to the attack, as it soon does, it finds an accumulation of fluid which has exuded from the wound ready for imbibition by the labium, and it is most probable that the delicate titillating movement of the organ, far from causing any further uneasiness, will tend actually to allay the irritation before set up. An undisturbed and plentiful meal can then be enjoyed, for so long as the blood is prevented from coagulating it will continue to flow from the puncture. Should, however, the insect have been allowed to pursue its operations from their commencement without molestation, the labium, in addition to performing this probable function of soothing titillation, will aid the setæ by appropriating any fluid which may escape them at the edges of the wound.

Last summer I had an opportunity of watching a Gad-fly at work on the back of my hand. I did not attempt to use a pocket lens for fear of disturbing it, but I was nevertheless able to obtain a tolerably good view of its operations. On alighting, it appeared to search about, as well as I could make out, with the labium principally, until a favourable spot was found, then a steadying movement of the whole body took place, down went the head and a sharp pain informed me that the setæ were doing their duty well. At the same time the labium could be felt, as well as seen, playing freely around the spot. This went on for some time, perhaps a minute, until an unguarded movement frightened my guest away, and abruptly terminated an interesting observation. A slight quantity of blood exuded afterwards from the puncture. The insect, however, did *not* return to make use of this, and I was therefore unable to verify my hypothesis. Man is, of course, a very occasional victim, but cattle and horses suffer severely in localities where the Gad-fly abounds. The species whose oral organs have been specially under consideration is amongst the least formidable. Several species of the genus Tabanus possess setæ of nearly twice the length, and the armature of the mandibles and maxillæ is proportionately developed. It is not surprising, then, that cattle should exhibit so much restlessness when in the vicinity of these winged foes, armed as they are with instruments against which even a thick skin forms a very insufficient protection.

NOTES ON MOSSES.

By William Stanley.

THOSE who have become interested in Mosses from the previous notes appearing monthly since July last will doubtless have felt a disadvantage in the system pursued when wishful to refer to any particular species; this disadvantage is considerably increased when we remember that at least one-sixth of the British Mosses either do not fruit in the United Kingdom, or that the production of capsules and spores is very doubtful. The remaining species as yet not referred to will, therefore, be taken in the order of their classification, and I would here mention that the London Catalogue of British Mosses and Hepatics, published by D. Bogue, price 9d., will be found extremely useful for the purpose of an index, while it also shows the comparative rarity or frequency of each species by means of a census indicating its distribution through the eighteen Watsonian provinces of Great Britain.

The family Andreæaceæ, named by Ehrhart in honour of his friend J. G. R. Andreæ, an apothecary and naturalist of Hanover, has only one genus Andreæa, consisting of eight species according to the London Catalogue; but Dr. Braithwaite, in his recently published monograph of this family, gives five species only, two having leaves nerveless, and three with leaves strongly nerved. *Alpestris* is considered a variety of *petrophila* and *grimsulana* or *frigida* and *falcata* varieties of *Rothii*. The Andreæaceæ are entirely confined to granite or slate rocks and boulders, and to mountains, stony regions, or the high latitudes of the Arctic and Antarctic zones, and this, no doubt, accounts for the great uniformity in their structure; their habit and valvular bursting of the capsule resembling that of the Jungermannia amongst which they were placed by the older authors.

They are acrocarpous Mosses of a reddish-brown or black colour, growing in small dense fragile tufts. Capsule ovate-oblong and sessile on the elongated sheath (vaginula) at the base of the fruit stalk, splitting into four rarely six or eight valves united at base, and also at the apex by the adherent lid, mitriform, torn irregularly.

Male inflorescence gemmiforme. Stems rigid or slender, forked, or with the leaves collected in small bundles on short branches (fasciculate). Leaves in five or eight ranks, patent, secund, smooth, or papillose, nerved or nerveless; ovate-lanceolate or subulate; the cells minute and thickened, rectangular at base, dotted or angular above.

* Leaves nerveless.

A. petrophila, the rock Andrea, with its beautiful brown or black

cushions, forms a conspicuous object on the rocks in mountainous districts, and so slightly attached at the roots that it is but seldom good herbarium specimens can be procured. Stems cæspitose, ½-1 in. high, nearly erect, simple, or forked. Leaves crowded, nerveless, varying much in form, direction and texture, from an erect base; ovato or oblongo-lanceolate. Areolation dense; the cells strongly and obtusely papillose at back. Capsules small. Male flowers on distinct branches with three concave, broadly ovate and pointed bracts. Fruiting from June to August. Fig. 40.

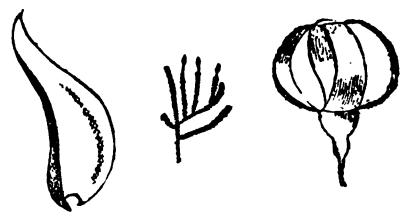


Fig. 40.

Five varieties of this species are found differing in colour, form, and direction of the leaves, but the cell structure exhibits great uniformity. The pale colour of the base and neck is also very marked in this plant.

A. alpina, the alpine Andrea, is common with us on mountain rocks, but it is utterly unknown on the Continent, with the exception of a few stations in Norway. The European species not found in Britain are *A. papillosa* from Spitzbergen and Lapland, and *A. obovata*, *A. Hartmanii*, and *A. Blyttii*, all three confined to Scandinavia. *A. alpina* fruits in June and July, and has erect, much-branched stems 1-3in. high, naked at base. Leaves nerveless densely crowded, smooth, glossy, obovate, and contracted a little below the middle, the margin obtusely serrate above the base, but entire in the upper part where the areolation is in parallel rows and dot like. Capsules oblong-ovate, black-brown, on a dark pseudopodium.

Two varieties of this Moss are found, β *compacta*, in densely compact tufts of a lurid blackish purple colour; λ *flavicans*, elongated filiform stems, the leaves more distant, and colour yellowish.

* * Leaves nerved.

A. Rothii, the black falcate Andrea, grows in black tufts on mountain rocks. Stems ½-1in. high, rigid, forked, and naked at base. Leaves patent, falcato-secund, nerved from an ovate base, lineal-lanceolate, smooth, entire at margin, nerve prominent at back, but vanishing at apex: areolation minute and dotted.

Capsule oblong-ovate, black-brown, pale at base. Male inflorescence gemmiform. Fruiting June and July. Three varieties of this species are found. β *frigida*, plants more robust; γ *hamata*, leaves rather lax and glossy; δ *falcata*, more slender, back; leaves falcato-secund from a broadly ovate base.

Closely resembling the last species is *A. crassinervis*. It is readily recognised by the subulate point or excurrent nerve, which is bordered with a single row of cells having the appearance of papillæ when seen by reflected light. Fruits July and August.

While in all the previous species the leaves and perichætial bracts, that is the bracts surrounding the base of the fruit-stalk, show considerable difference in shape, &c., in *A. nivalis*, the tall slender Andrea, they are alike in form. The capsule is also deeply cleft into 4, 6, or 8 valves.

It is a dioicous Moss in soft, blackish green, widely spreading tufts. Stems 3-4in. high, slender, reddish, branches forked. Leaves patent, secund, the lower, smaller ovato-lanceolate; the upper, falcato-secund, acute, densely papillose on both sides; nerve narrowed, and lost in the apex; capsule a little exserted, oblong; calyptra very small, conical. This fine species, fruiting in July and August, appears to attain its fullest development on the Grampian range, its habitat being the higher mountains of Scotland, on dripping rocks, at the limit of perpetual snow.

Found with the typical form on Ben Nevis and Ben Macdhui is a variety β *fuscescens*, with stems more flexouse and flabby, and strongly falcate leaves of a brown colour.

A rather minute plant is the small-mouthed beardless Moss, *Gymnostomum microstomum* with stems $\frac{1}{8}$-$\frac{1}{4}$in. high, and fruiting in spring on banks and in fields.

Weissia crispula, the curly leaved Weissia, is found fruiting in June and July on mountainous rocks, where also is found *Rhabdoweissia denticulata*, the toothed streak Moss.

A very small and pretty series of plants, greatly resembling each other and requiring care to distinguish, is the genus Seligeria, Bristle Mosses, named in honour of the Silesian pastor Seliger. Found growing on rocks; the leaves are in many rows, lanceolate or subulate, nerved, cells minute and quadrate above, large and rectangular at base, sometimes with coloured angular cells, see Dicranum, calyptra cucullate, capsule ovate or globose with a distinct neck; peristome of 16 lanceolate, flat, smooth, rigid teeth, rarely cleft, sometimes none; spores smooth. Inflorescence monoicous.

Distinctly separated from the rest of the species, being without a peristome, is *S. Doniana* or *Donii* Don's bristle Moss. It is one of the most elegant of our minute Mosses, and probably often overlooked from its inconspicuous appearance. Of a gregarious

habit and yellowish-green colour, the stems are very short and simple. Leaves erect, straight, lanceolate-subulate, acute, nerve occupying all upper part of subula; Capsule truncate-ovate on a straight yellowish seta. Fruiting on limestone and sandstone rocks in August. *S. pusilla*, the long-leaved bristle Moss, is not uncommon on damp shady rocks of sandstone or limestone in loose, dwarf, silky, dark-green tufts. Stems $\frac{1}{8}$in. simple or forked. Leaves lanceolate-subulate, very narrow, acute, faintly crenulate above, nerve thin vanishing at apex; capsule erect, ovate, teeth of peristome distantly barred; lid with an oblique beak. Fruits in May and June. Fig. 41.

Closely resembling the last, but with leaves more acutely subulate is, *S. acutifolia*, the variety *B. longiseta* is, however, only

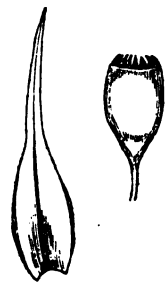


Fig. 41.

Fig. 42.

found in Britain. Found fruiting in May and June in the fissures of calcareous rocks. It derives its name from the longer seta which elevates the capsule above the perichætial bracts; lid with a long oblique beak. *S. trifaria*, or *tristicha*, is a very rare species found on dripping calcareous rocks, a ready means of identification being afforded by the slender branches, which, in the moist state, show distinctly the trifarious arrangement of the leaves. Another rare species fruiting in May and June, and found on detached chalk blocks, partially embedded in soil, is *S. paucifolia*, distinguished by its enlongated capsule. *S. setacea* or *recurvata*, the curve-necked bristle Moss, is found on shady sandstone rocks or stones, fruiting this month and next. It is an olivaceous-green, with stems, very short, and fragile, simple or forked. Lower leaves oblongo-lanceolate, upper leaves longly subulate, flexuose,

acute, entire, nerve longly excurrent; calyptra rather large; capsule obovate-elliptical, with a swelling neck, inclined; lid with a straight subulate beak. Also, fruiting in April and May, though much less frequent than the last, being found only on chalk cliffs and calcareous rocks, is *S. calcarea*, the short leaved bristle Moss. Of a dull blackish green, the leaves are short; broad, ovato-lanceolate; entire; nerve flattish and faint, but stronger towards apex; capsule turbinate on thick yellowish brown seta, with a shortly rostrate lid.

The summit of Ben Lawers is the only recorded station for the very rare *Stylostegium cæspiticium*, the minute tufted beardless Moss; while also fruiting in summer, and found in the northern regions, in the fissures of Alpine rocks, is *Arctoa*, or *Dicranum fulvellum*, the brownish fork Moss.

Fruiting in June, and not uncommon on rocks in sub alpine or hilly districts, is *Cynodontium Bruntoni*, Brunton's fork Moss. It bears great resemblance to *Weissia cirrhata* in the foliage. See page 61, but the capsule is more turgid, shorter, and has a very different peristome. *C. virens* is another very rare Moss found on Alpine rocks in the Ben Lawers' province, as also *Dicranella Grevilleana*, Greville's fork Moss, and *D. arcticum*, or *glaciale*. *D. spurium*, the wide-leaved fork Moss, is a very fine species, and is distinguished by its broad tapering leaves. Although fruiting in June, fertile plants are not often found, its habitat being moors and bogs in limited localities. Stems covered with radicular fibres; leaves ovate-lanceolate, acuminate, serrate, papillose on the back; capsule sub-cylindrical, striated, cernuous.

The Leucobryaceæ is a family comprising 65 species remarkable for their pale colour and similarity to the Sphagna in the composite structure of their leaves. They are almost entirely tropical, and our British species *Leucobryum glaucum* is the only representative in Europe. Although common on wet heaths and in woods, the fruit, which ripens from October to March, is very rare. This rarity of the fruit is compensated by there being commonly found on the terminal leaves of the stems of the female plant, a minute tuft of woolly fibriles, developing a cluster of young plants, which, falling to the ground, grow into a new colony.

It grows in dense spongy tufts. Stems 1-6in. high, forked; leaves in thirteen rows, soft, patent; entire, broadly lanceolate, cuspidate with incurved margins. Capsule oval, cernuous, strumose; lid with a long oblique beak. Dioicous. Generic name from λευκος white. *Ceratodon cylindricus*, the narrow-fruited Fork-Moss, found on sandy banks, is not common, and the fruit, which ripens in April and May, is very rare. This Moss is not unlike Dicranum Crispum, but it may be easily distinguished by the sharply denticulate or papillose leaves.

Resembling Dicranum in habit, and with a similar peristome, is the genus *Campylopus*, or Swan-necked Mosses, so called from the capsules being on an arcuate or flexuose, or rarely straight seta; from Καμπυλος curved, πους a foot. They inhabit turfy ground and rocks, and several of the species produce slender flagelliform branches, by which they are propagated.

The leaves are densely crowded, imbricated when dry, erecto-patent when moist, and have a broad nerve of several strata of cells, furrowed or smooth at the back, and frequently terminating in a white hair. A curious falling off of the leaves in several species of this genus is noticeable, same as in Dicranodontium, and is attributed by Lindberg to a change in the contents of the basal cells, akin to the fatty degeneration in animal tissues, the result being the arrest of the circulation through those cells, and their separation from the stem. Calyptra cucullate; fringed at base. Capsules generally striated, deeply furrowed when dry. Annulus of 1-3 series of cells. Dioicous.

C. pyriformis, the dwarf Swan-necked Moss, is not uncommon on heaths and moorlands, and by sides of ditches; fruiting from December to May in large low olivaceous or bright green tufts. Stems ½-1in. high, erect, with radicles at base only. Leaves erecto-patent, lanceolate-subulate; longly setaceous, denticulate at point; nerve ⅓ width of base; furrowed at back; Capsules oval, pale; lid conico-subulate; red.

A plant more robust and leafy than the last, and with fine branched pale radicles on the stem, is *C. fragilis*. It fruits from December to April on sandstone rocks and turfy soil in sub-alpine districts, and is ½-2in. high, of a pale-green, densely leafy above with innovations (extensions of the stem) producing at apex fragile branches with long narrow leaves. Leaves erecto-patent, straight, narrowly lanceolate, very thin and pale at base. Capsule bent down among the leaves, oval, olivaceous; lid, pale red.

A pretty species known by its very compact tufts is found only on the Highland mountains, but not in fruit. *C. Schimperi*. The leaves are erect, straight, lanceolate-subulate, and without the small lobes, (auricles) at the base; nerve ⅔ width of base.

A very rare species, found only in Hebridean Islands, is *C. Shawii;* also rare on Alpine rocks is *C. Schwarzii*, and its minature *C. subulatus* or *brevipilus*.

Fruiting from November to February on turfy ground and moist sandstone rocks is *C. flexuosus*, the rushy Swan-necked Moss. It is seen in dense glossy yellow-green tufts. Stems 1-3in. high, interwoven with reddish fibriles arising from back of leaf at base. Leaves lanceolate-subulate, channelled, serrulate at apex; nerve broad, nearly ½ width of leaf base; occupying all the apex, furrowed at back. Capsules ovato-elliptic, pale; furrowed (sulcate);

lid conico-subulate. A variety *β paludosus*, from boggy heaths in sub-alpine districts is much more robust, 3-4in. high, and with the base of the leaves often tinted with purple.

Two rare species are *C. paradoxus*, gathered on pearly soil in sub-alpine districts, and *C. setifolius*, found on rocks among grass and heath.

C. atrovirens, the bristly Swan-necked Moss, is common on wet rocks and peaty ground on all our mountains, growing in dense dark green silky cushions; stems slender 1-5in. high, repeatedly forked.

Leaves gradually larger towards apex; erecto-patent, lanceolate-subulate; auricled; nerve dilated, ⅓ width of base, sulcate at back, excurrent in a long toothed hoary point. Fruit not found. Fig. 42. *C. introflexus* is a rare species. *C. brevipilus*, the compact Swan-necked Moss, inhabits moist heaths, and is of a glossy yellow green. The stems are slender, fragile, 1-3in. high, with scarcely any radicles. Leaves narrowly lanceolate-subulate, tipped with a short denticulate hyaline point, sometimes wanting; nerve ⅓ width of base; auricles slightly developed. This species differs from all the others in habit and areolation, the upper cells having a distinct S like curve, while the back of the leaf near the apex is rough. A barren and rare Moss is *Didymodon recurvifolious*, the drooping-leaved Didymodon, and found only on the Scotch mountains, *Ditrichum glaucescens*.

D. flexicaule, the wavy-stemmed, is not infrequent on calcareous rocks on the Scotch mountains and in Derbyshire. Growing in glossy yellowish-green tufts with stems 1-3in. high or more. Leaves lanceolate-subulate, concave, denticulate at apex, nerve broad. Capsule erect, ovate-oblong, small, with an amulus; teeth 32, long and unequal. *Trichostomum mutabile*, the variable Trichostomum, frequents moist or shady banks in calcareous soil, and is found fruiting in June and July. Leaves lanceolate or ligulate; spreading, crisped when dry, margain plain; nerve projecting into a slight mucro; capsule ovate; lid rostrate, annulus none.

Greatly resembling the last species in size, &c., is *T. crispulum*, the curly-leaved Trichostomum, but with linear-lanceolate leaves, concave and almost hood-like at the apex; nerve slightly excurrent; capsule erect, regular, oval with an oblique beak; annulus none. Found on limestone rocks near the sea.

Two species not fruiting complete the list of the genus *T. flavovirens*, and *T. littorale*.

Of the Tortulas or screw Mosses, *T. canescens* has only been found near Hastings, Sussex. *T. fragilis* on Ben Lawers, and in Ireland. *T. squarrosa* on the chalk in the south of England and Ireland, and *T. atrovirens*, in March, on dry banks, &c., near the sea.

T. Hornschuchiana, Hornschuch's screw Moss, is found fruiting in April and May on walls and rocks, also on banks in marly soil, and is frequently confounded with *T. revoluta*, growing on limestone walls, from the revolute margins of its leaves, but the leaves are more spreading and more evidently recurved, ovato-lanceolate, acuminate, nerve thinner and more excurrent; capsule longer with a narrow annulus.

Frequent on walls, but very rarely in fruit, is *T. vinealis*, the soft-tufted Screw Moss. Leaves recurved, ovate-lanceolate, with plain margins in the upper half; capsules ovate-oblong, erect with an annulus; peristome short, pale and almost white, with a broad basilar membrane.

(To be continued.)

ADDRESS TO THE MEMBERS OF THE ROYAL MICROSCOPICAL SOCIETY.

By Professor P. Martin Duncan, F.R.S.

(Abstracted from the Journal of the Society.)

EVERY Fellow of this Society who has attended the evening meetings during the last twelve months must have been struck with the very practical nature of our proceedings, and that the observations made, and the apparatus exhibited and described on those occasions, indicated a growing desire for the perfection of the Microscope. At the same time it must have been evident that the application of the instrument to its proper purposes is open to many sources of error, and that there is an amount of intelligence and knowledge required in the management of the Microscope, which is the result of much labour, thought, and experience. Common sense might tell everybody this, but it sometimes happens that when a man has invested a certain number of guineas in an instrument he imagines he is correspondingly endowed with the abilities of a microscopist in the true sense of the term. On the other hand a very large number of able men become possessed of instruments humble in appearance and not costly in any sense, and they rest satisfied that a Microscope is a Microscope, and believe, therefore, that they see the true invariably. One of the benefits of belonging to our Society is the opportunity of seeing objects properly shown by the ablest manipulators, and of hearing communications on the imperfections and corrections of the instrument, and it would be well if our list,

full as it is, were crowded by those scientific men who constantly use the Microscope in original research in biology. A considerable experience impresses me that the majority of students, and not a few professors, not only use indifferent instruments, but also carefully avoid all those practices which we know are absolutely necessary for correct microscopy. A thing is seen, therefore it must be real; one man sees a spiral line, another a circle, another a series of dots, using the same object and different Microscopes. They describe, and debate, and each is self-satisfied. Yet all the while had they had a master in microscopy their differences could be terminated.

A pleasant evening with the Microscope generally means a painful time for the eye. A good glare of light, thanks to lamp, condenser, mirror, and forgotten diaphragm, appears to be almost invariably a desideratum to the beginner. Experience teaches, however, and the advanced microscopist never uses more light than is absolutely necessary, and increases and diminishes the illumination during the careful observation of an object, not only by employing a less intense source of light, but also by using diaphragms of different sizes.

Since microscopy has been extended to the examination of sections of rocks composed of different minerals, the truth that some can be roughly distinguished by their dichroism under the polarizing ray, the analyser not being used, has become apparent. The polarizer is also useful in another manner. Researches have been undertaken to examine into the influence of the polarizing ray upon substances which may or may not give the usual phenomena under the analyser. Polarized light carefully manipulated is very useful in examining thin sections of corals which are made up of closely placed fusiform and long alternating prisms, with geometrical prisms of carbonate of lime in planes one over the other, and often radiating from different points. Shadow and high light succeed when the Nicol is rotated, and minute details become apparent which are not seen, or are only feebly defined, by ordinary light reduced in its intensity to that of the polarizing ray by the use of diaphragms.

Some time since, in investigating the structure of a fossil which was composed of close radiating and occasionally inosculating tubes with very thin walls and a distinct lumen, all mineralized with calcite in the glassy, non-crystalline form commonly seen in fossils where there is much space unoccupied by structure, the polarizing ray certainly made the tubes more distinct than the ray reflected from the mirror alone, and by rotating the substage Nicol, the position of certain tubes which were invisible before could be ascertained; that is to say, dark lines appeared limiting tubes which were invisible under ordinary illumination.

The application of the whole polarizing apparatus is very useful in working at the minute superficial structures made up of thin and highly refractive plates of organic carbonate of lime. The glare of light under ordinary illumination, and even when the polarizer only is used, prevents the true surface being focussed, or if it is fortunately hit upon, it is more or less invisible. But the analyser being placed across the direction of the polarizing ray the true surface can be found by the definition and distinctness of the clear colours and the intermediate lines. Take away the analyser, and often new structures appear to the eye. As a matter of practice I find that this method is exceedingly useful.

Circumstances have brought me in contact with cheap Microscopes, and certainly whilst it may be said that some of the objectives are fairly good, the eye-pieces are on the miserable "par" with the rest of the apparatus. I cannot avoid believing that during the next few years attention will be paid to increasing the merits and adaptability of eye-pieces whatever may be their special character.

In the address which I had the honour of delivering to you last year I remarked upon the comparative values of object-glasses with high and low numerical apertures, and I took pains to defend the employment of lenses with wide apertures in examining minute objects, and also to state that both kinds of objectives are necessary for investigating into the structure of minute objects. I suggested what has commended itself to every advanced microscopist for years past, that an observer should provide himself with both classes of objectives, and that he should use those with a moderate aperture for common and preparatory work, and those with a high numerical aperture for subsequent and careful examination.

Very few microscopists care to correct their objectives during ordinary work, and principally because they have not seen the difference made in the appearance of an object by the process when it has been carefully carried out. But when an object, hitherto unsatisfactorily defined, presents itself under a clear and definite aspect, conversion to the opinion that there is an absolute necessity for correction in all delicate investigations regarding minute structures speedily ensues. There is no doubt that with very few exceptions the microscopic work relating to the morphology of the animal and vegetable kingdom has been conducted either without corrected objectives, or with those which have an average adjustment. I pointed out in my last address how abnormally thick, slender and excessively minute bodies appear under a high amplification; this is partly due to a want of correction, and mainly to another cause which is not necessary to revert to. Now I have no hesitation in saying that similar abnormalities are constantly recorded as truths, and for that same reason which

causes excellent observers to differ in a most remarkable manner about the appearances of the same object under different Microscopes.

It has been put very forcibly by Dr. Dippel that if the shape of the object is unknown, correction may be a mistake, and that when the focus is at a lower plane than the summit of the object, correction may positively mislead.

There is no doubt that an image seen under a certain correction, and which is stated to be normal, is modified by under- and over-correction.

How to get at the truth is difficult, except in the instance of geometrical bodies and definitely parted lines, but the examination of the same object by many observers with different instruments gives experience, and without indulging in calculations, including the method of least squares, it is finally settled that such and such is the real shape.

The possibility of error remains, however, and it is perfectly evident that many a difference of delineation of carefully investigated objects results from non-correction and over- and under-correction. One cannot but help thinking that the difficulties in correcting dry objectives of high amplifying power and great numerical aperture, will lead to the almost constant employment of immersion objectives. And really the only researches which are rendered more difficult by the immersion principle are those which have rendered the name of Dr. Dallinger so illustrious. There is no doubt that it is impossible to prevent the admixture of the medium with the water below the thin cover when minute organisms are followed here and there and often close up to the edge of the glass cover.

Amongst the results of not correcting objectives are want of definition, haziness, and the production of certain colours, and this last phenomenon is often observed in objectives which are corrected up to a certain degree and fixed. It is the fashion to correct and fix so as to obtain a certain amount of chromatic aberration, a ruby tint being considered the best. This is to obviate the effect which the perfect achromatism of a glass of large numerical aperture has on the eye.

There can be no doubt that the majority of the recorded histology of the minuter structures will have to be worked over again with carefully corrected objectives.

In concluding these remarks on the Microscope itself I must enter a protest against the clumsy method of pushing a glass slide with a valuable and important object upon it with the fingers, under the objective and moving it about. Cheapness of the instrument and want of scientific care are the temptations to and the causes of this very frequent source of error, which is intensified

by the common fault of want of perfect flatness of the plane surface of the stand.

The beautiful adaptation of a sliding glass restricted by a point, whilst it relieves the microscopist from the expenditure involved by a complicated brass movement, is so easily fitted that there is no excuse for employing the fingers alone.

THE ACTION OF TANNIN

ON THE CILIA OF INFUSORIA, WITH REMARKS ON THE USE OF SOLUTION OF SULPHUROUS OXIDE IN ALCOHOL.

By Henry J. Waddington.

(Extracted from the Journal of the Royal Microscopical Society.)

I AM desirous of bringing to the notice of the Society a matter which, though small in itself, may be of some use in the hands of experts. The immediate subject is the peculiar action of tannic acid on the cilia of *Paramœcium aurelia;* but I may, perhaps, be allowed to digress a little at starting, in order that I may call attention to the methods I have used for keeping Infusoria for microscopical observation.

There are two methods which I have found very useful for this purpose. If small fragments of very hard burnt biscuit are dropped into water containing Infusoria, and held in suspension by pieces of weed or *Confervæ*, these crumbs, after a short time, form a nucleus from which fungoid growths spring freely, so that from a fragment of biscuit 1-32nd in. in diameter we may have a spherical growth of 3-4ths in. in diameter. These growths seem to be peculiarly fitted for the development of certain kinds of Infusoria, and they have this advantage—that when lifted out of the water, the filaments necessarily collapse, and act as a net to inclose whatever may be among them. When placed on a slip, a portion of these filaments may be spread out with needles, and they then serve the purpose of so retarding the motions of the Infusoria that their observation is comparatively easy, the extreme fineness of the filaments allowing the highest powers to be successfully used. It is necessary that the biscuit should be very hard and well baked, otherwise the fragments disintegrate. This method applies to Infusoria in aquaria, or in comparatively large quantities of water; but where they are contained in small troughs, I find that they thrive well on leaves of *Anacharis* or filaments of *Conferva*, which have been reduced to a pulp with a little water

in a mortar. If a few drops of this are occasionally added to the trough containing the Infusoria they may be kept satisfactorily for a length of time. The small trough I have has been so kept for more than four months.

In trying the effect of various chemicals on Infusoria—principally *Paramœcium aurelia*—I was led to use a solution of tannin, or tannic acid; and I was surprised to find that the immediate action of this chemical was to render the cilia visible without any manipulation of the light. It may have been noticed that when these Infusoria have been killed by ordinary means, such as heating the water in which they are contained, the cilia are very difficult to observe, probably owing to their great transparency, so that no correct idea has, I think, been obtained of their size or quantity.

On placing, however, a drop of water containing *Paramœcia* on a slip side by side with a minute quantity of a solution of tannin, and making a junction of the two, it will be seen that the instant the *Paramœcia* approach the mixed fluids their motion is arrested, of course in a greater or less degree according to the strength of the tannin. They are generally rendered perfectly quiescent, and the cilia begin to appear and continue to develope, until the body of the animalcule appears entirely surrounded by them. The symmetry of the cilia depends upon the strength of the solution; if it is too weak, it seems as if the animal had had time to slightly move the cilia, by struggling, as it were, as they appear crossed and crumpled; but if the solution of tannin happens to have mixed with the water in a better proportion, the cilia are more rapidly developed, and stand out almost parallel, hardly one being seen to overlap another.

To bring out the best appearance of the cilia over the whole of the surface of the *Paramœcium*, the parabola is required; the animal then appears as if it were supported on the slip by its cilia.

If the tannin solution is strong the *Paramœcium* is almost instantly rendered motionless, and the cilia appear to be entirely removed, remaining in a more or less confused state at the extremity.

I have shown this action to several microscopists, and so contrary is the remarkable development of the cilia to received ideas, that on nearly every occasion I have been met with the remark that they were not cilia but fungoid growths. This is, however, entirely disproved by the fact that they are developed, as it were, instantaneously.

The action of the tannin on the cilia I believe to be analogous to its action on gelatine, rendering them leathery, and consequently opaque. It does not appear to kill the *Paramœcium* itself—at least for some little time, unless the solution is very

strong, as the rhythmical contraction and expansion of the contractile vesicles may be still observed. In the most successful observations it is probable that the tannin solution has been of sufficient strength to act upon the very delicate cilia, and, as it were, to paralyse them; while it has not been of sufficient strength to kill the animal outright. In the face of the accepted theory that ciliary motion is involuntary, it would be incorrect to say that the tannin acts upon the cilia in such a manner as to render them beyond the animal's control; but the cilia are certainly rendered inert, while the functions of the animal are but little impaired for a time.

The form of tannin which I have found most convenient to use is the glycerole of tannin, which is merely tannin dissolved in glycerine in the proportions of one part to four. It is a thick, viscid body, very stable, easily miscible with water, and consequently very manageable, as the quantity added to the water under examination can be well adjusted, and the action is more satisfactory than it would be if a solution of nearly the same specific gravity as water were used. Tannin in alcohol is not advisable on account principally of the repellent action between the alcohol and the water.

That the immediate action of the tannin in moderate quantity is not to kill the *Paramœcium* is, I think, apparent from the fact that Infusoria much more minute than *Paramœcia* seem to be little affected by it. I have constantly seen these become entangled in the cilia of *Paramœcium* that had been rendered motionless by tannin, and extricate themselves after a time apparently little affected by it. But such Infusoria have not possessed cilia of the same character as *Paramœcium*. On *Stylonychia* the tannin does not appear to have so decided an action, and whenever the cilia take the form of setæ the Infusoria seem much more capable of resisting its paralysing action, the peculiar jerky motion of the setæ being kept up for some time.

I have made the remark that I think no correct ideas have hitherto been held as to the size and quantity of the cilia; at any rate I have never seen any drawing, or read any description of *Paramœcium*, as it is observed after the treatment by tannin. That the appearances observed are really cilia may be easily verified by the action of osmic acid, which kills the *Paramœcium* at once, and renders the cilia visible, but not to the extent that they are so rendered by the tannin.

I may also make allusion to the action of another chemical body on Infusoria, and to the advantages it seems to possess in microscopical research. This body is sulphurous acid, or, in the form in which I have found it most useful, solution of sulphurous oxide in alcohol. The properties of sulphurous oxide are too well

known to require any comment. I will merely mention that it is soluble to the extent of 30 volumes in 1 volume of cold water; but this solution soon changes into sulphuric acid by the action of air. If, however, the gas is passed into alcohol the quantity absorbed is greatly increased. If this saturated solution of the gas in alcohol is added to water, the gas, or the greater portion of it, is instantly thrown off. This alcoholic solution I have found most satisfactory in the observation of Infusoria. When a minute quantity is added to a drop of water on a slip, there is at first the repellent action between the alcohol and the water. This being overcome, the gas is given off, and its effect upon infusorial life is at once apparent. If the solution is strong they are at once killed, and in most cases, if the Infusoria are ciliate, the cilia are rendered visible; but if the deadly solution has been strong enough to be hurtful but not deadly, examination may be carried on satisfactorily. The Infusoria are rendered almost motionless, while the ciliary action may be well observed.

If, under these conditions, the slip containing *Paramœcia* is allowed to become dry, the points of attachment of the cicilia to the body of the animal are exceedingly well defined. Where the cilia have become detached they almost resemble raphides.

I think that this reagent—sulphurous oxide in alcohol—is one that may prove of great use in microscopy. It is not so deadly as osmic acid, but it has a very marked action on Infusoria; while it is by no means so dangerous, and its cost is much less. The solution in water possesses very powerful bleaching properties, and the alcoholic solution, which is perfectly stable, furnishes a ready means of obtaining small quantities of sulphurous acid, for bleaching or other purposes.

I would merely add in conclusion that I consider I ought almost to apologise for dealing with a subject so very foreign to my usual microscopical pursuits. The experiments I have described have been carried out more as a microscopical recreation than as a scientific research; but they have appeared to me, and to those microscopists to whom I have shown them, to be of so much interest, and so capable in the hands of those more conversant with the subject than myself of further extension, that I have been induced to bring them forward.

TESTING MICROSCOPE OBJECTIVES.*

By Dr. Allen Y. Moore.

WITH all the microscopical literature we have, it is surprising to see how little attention objectives have received, and, at the same time nearly every work on the subject tells us that the objective is the most important part of the entire instrument. That this is a fact, I think no person will deny, and if the objective be otherwise than perfect, a knowledge of its imperfections will help the observer by giving him an idea of how far his instrument may be considered trustworthy.

All first-class objectives in which the angular aperture exceeds 75° or 80° in air, should have a correcting collar; and although it makes less difference with the lower powers, the higher ones should be so constructed that the collar moves the back system of lenses.

Bad centering and bad form are conditions which are inexcusable. By bad centering is meant, that the centres of the lenses are not in a straight line. By bad form is meant that the curves of the lenses are not segments of true spheres. Either of these conditions may be detected by what is known as the artificial star. This is nothing more than a very small globule of mercury upon which a strong light is thrown.

If such a globule be placed in the centre of the field and carefully focussed, a bright spot, which is the image of the source of light, will be seen. If the tube be now racked up or down, so as to throw the globule considerably out of focus, it will be seen that the bright spot expands and becomes a large circle of light. If the lenses be truly formed and correctly centered the edge of this circle, or expansion of light, will be true and even, but in case the lenses are not in a straight line, the circle of light, or coma as it is more frequently called, will not be perfectly round but will be seen to bulge more on one side than on the other. Bad form is shown by an irregularity of the outline of the coma, and the shape of the coma will indicate the shape of the curved surfaces of the lenses.

Chromatic and spherical aberration next deserve attention. Chromatic aberration is that condition in which the white light, after having been decomposed by the refracting surfaces of the crown lenses, is not properly recomposed by the proper action of the flints. When an objective brings the violet light to a focus before the red, it is said to be chromatically undercorrected; if the red rays meet sooner than the violet, it is said to be overcorrected.

* Read before the Griffith Club of Microscopy, of Detriot, February 6th, 1883.

With the lower powers the artificial star is about the best test for determining this condition. With the glass now used by opticians for the construction of objectives, perfect achromatism has never been attained; there being at best a secondary spectrum caused by the unequal dispersion of the various parts of the primary spectra of the flint and crown glass lenses. These colors are a pale green and pale violet. If a well-corrected objective be focussed upon the mercury globule, and then brought without and again within the focal point, it will be seen that the circle of light has a colored border, and that when the globule is without the focus this border is of a pale green color, when within it a pale violet. These colors indicate the best chromatic correction, and any variation will show itself by more or less change in the color. If undercorrection be present it is indicated by the green taking on a bluish cast, or, if very much undercorrected, a distinct violet is to be seen. In the place of the proper violet—that is when within the focus—a reddish violet, or even a brilliant red, is seen. Overcorrection is indicated when in the place of the green, a yellowish-green, brilliant yellow, or orange is seen; and in the place of the proper violet, a blue border is seen. This applies, not only to the mercury globule when used as stated, but to almost any opaque border of an object. With the higher powers, a very convenient way is to use a well-marked diatom, or, what in most cases is still better, a strongly marked podura scale. In any such objects as these, the dots or spines appear violet and the interspacing green when the chromatic correction is right; and in the case of under or over correction these colors give way to the colors already mentioned as occurring with the artificial star.

The correction of spherical aberration is more important than that of color. By spherical aberration is meant that the rays of light which pass through different zones of the objective do not unite in one point in the eye-piece. If the peripheral rays meet before the central ones, the objective is said to be spherically undercorrected, while if the reverse be the case, overcorrection is present. With the artificial star the presence of spherical aberration is shown by the coma, or circle of light, expanding unequally when the globule is placed within the focus, or the same distance beyond the focus. Should the greater expansion of the coma take place when the distance between the objective and globule is increased, the objective will be undercorrected, but when the greater expansion is within the focus, overcorrected.

I have here this evening a one-inch objective with which, by the aid of the artificial star, I shall practically illustrate the appearances seen with a well-corrected glass. The workmanship of this lens is superb, and, although of moderate angular aperture, it is much better in definition and resolution than many lenses of much wider

angle. By the aid of the back system of a cheap English one-fourth-inch objective, I shall illustrate the irregularity of outline of the coma, which indicates a want of true form or curves, of the lenses.

Angle of aperature is of great importance. By this is meant the angular breadth of the cone of light received from the object by the objective. This is to be determined by direct measurement. As convenient a method as any, is by using a stand which has a graduated rotating base, or graduated swinging substage bar. The objective should be put upon the stand and accurately focussed, the stand being in a horizontal position. A lamp is then placed several feet distant, and, by turning the stand upon the base, the aperture is ascertained, the light being allowed to divide the field equally at each extreme of the angle. In case the measurement is to be made by the aid of the substage bar, this may be made to carry a small candle or lamp, which should be diaphragmed to a narrow slit. The measurement, as before stated, should be made from the point at which the light bisects the field. When it is desired to measure balsam aperature, or the angle of the rays in Canada balsam, it is necessary to use the proper immersion fluid, and to have a hemispherical lens placed under the object (the object, of course being balsam mounted) whose centre of curvature is in the plane of the object. The readings upon the base or substage bar then indicate the angle within the hemispherical lens; and if this be of the same glass as the front lens of the objective, the true glass angle, or, as it is more commonly called, the balsam angle, becomes known.

I think it may not be unjust to say that many of the objectives of our best makers will fall considerably short of the aperture claimed for them. A recent $\frac{1}{6}$ for which an angle of 130° in balsam, was claimed, only measured 125°; a very fine $\frac{1}{10}$ for which a 140° was claimed, only gave 116°; and a $\frac{1}{10}$ claimed to have 105°, only gave 97°.

An objective may have a very wide angle of aperture and still be inferior to that of another objective of less angle. In such cases the trouble is generally due to a want of proper correction for chromatic and spherical aberration. In measuring aperture it is always well to select some test-object which shall be more or less difficult to resolve with the objective to be measured. It should then be focussed and carefully watched as the stand or mirror bar is turned, until the very best resolution is attained. By increasing the obliquity of the light it may then be seen whether the extreme rays which traverse the periphery of the objective are really of any use. For example, in the $\frac{1}{6}$ already mentioned the light will enter the objective at 125°, but the light which forms the image only enters at 120°; hence the objective is no better than one properly corrected having 120°.

Flatness of field and penetration are two qualities of which I can say but little. Many of the best objectives have a very flat field, but I have never yet seen one in which the definition was really good to the extreme edge. It is easily determined by examining any flat, well-marked object, such as a section of echinus spine with the lower powers, and a slide of evenly spread blood-corpuscles with the higher ones.

Working distance is of especial value in high powers. It is the distance of the object from the front lens when in focus. It can only be ascertained by actual measurement. For this purpose a scale and vernier on the ways and the body are very desirable, but I have never yet seen a micrometer screw sufficiently good to correctly measure the working distance of the higher powers. The best way of measuring the greatest working distance is by having a number of cover glasses of various thicknesses, accurately measured, and see which is the thickest that the objective can be made to focus through, using the ten-inch body. It will be found that the actual distance between the object and the objective will increase with an increase in thickness of cover-glass or the density of immersion fluid.

The magnifying power of the objective is a matter well worth knowing. Many objectives are underrated; for example, a recent $\frac{1}{10}$ which I measured only gave 84 diameters at its greatest power, while another $\frac{1}{10}$ gave the unusual power of 120 diameters, thereby being a true $\frac{1}{12}$.

The correct point from which to measure the power, is the optical centre, but as this changes with every change of immersion fluid or length of body, it is not practicable, hence the front surface of the front lens is generally taken as the standard, and the image is measured at a distance of 10 inches from this point. The best way of doing this is by placing a micrometer on the stage and a piece of finely ground glass at the end of the body instead of the eye-piece. The distance of the ground glass from the front of the objective should be ten inches. If the micrometer be now illuminated by very intense lamp light, or in the case of the higher powers by sunlight, and carefully focussed, the image of the lines will be seen on the ground glass. Their distance apart may then be dotted on the ground glass and then carefully measured. If the distance apart of the dots upon the ground glass be now divided by the real distance of the lines on the micrometer, the linear amplification will be the result.

The power of the eye-piece may now be determined from that of the objective. The eye-piece should be placed in the tube, with its field-lens in the case of a negative eye-piece and its focal point in the case of a positive eye-piece, at a distance of ten inches from the front lens of the objective. The power of the microscope

should now be taken at ten inches with the camera-lucida in the usual way. The power of the microscope, divided by the previously determined power of the objective, will give the power of the eye-piece in diameters.—*American Monthly Microscopical Journal.*

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

SUBSCRIPTIONS FOR 1883. The current year's subscriptions became due in January last. Will those subscribers who have not remitted, kindly do so at once?

PICROSULPHURIC ACID is used for killing marine organisms at the Zoological station at Naples. It kills quickly, rapidly replaces the sea water, does not harden, and may be directly replaced by alcohol. It is composed of a saturated solution of picric acid in water, one hundred parts, with two parts by measure of concentrated sulphuric acid. When mixed, filter, and dilute with thrice its bulk of water.

ALCOHOL has been used with much success in mounting *Lophopus crystallinus* with the tentacles expanded, by Mr. H. C. Chadwick, of the Manchester Microscopical Society. The spirit is blown as a spray upon the surface of the water containing the organisms; it mixes slowly, and the tentacles are thereby not retracted.

HOMOGENEOUS OBJECTIVES.—We have lately had an opportunity of examining a $\frac{1}{12}$th homogeneous immersion lens of Leitz; it has a balsam angle of 100° (82° B.A. being equivalent to 180° in air), and stands deep eye-pieces very well. *A. pellucida* is shown as lines in its shorter direction, and *Navicula rhomboides* come out beautifully in squares without any tedious manipulation. The price is but five pounds, so that this lens will be found worthy of notice by many microscopists.

GUNDLACH'S NEW LIST OF OBJECTIVES.—We find Gundlach has listed a one-inch objective of 85°, a half-inch of 110°, and also some cheap glycerine immersions, of from 95° to 100° balsam angle.

PHOTOMICROGRAPHS.—Dr. George Sternberg has a work in the

press on this subject which will be illustrated with seventeen heliotype plates from his best negatives.

THE THAMES MUD BANKS.—Dr. H. C. Sorby is busy making a microscopical investigation of the deposits in the Thames. His report will be looked forward to with interest.

MR. BOLTON'S PORTFOLIO OF DRAWINGS.—No. 9 of this series was issued in March last. It contains drawings and descriptions of—

Uvella virescens.
Pyxicola affinis.
Stichotricha remex.
Trochosphere of Alcyonidium.
Œcistes umbella.
Cephalosiphon limnias.
Melicerta tyro.
Floscularia regalis.
Anuræa curvicornis.
Leptodora (young stages).
Idya furcata.
Haplobranchus æstuarinus.
Ammothea fibulifera.
Water-mite *(Atax albidus).*
Water-mite.
Elver, or young eel.

We are glad to notice that the drawings are more uniform in size than heretofore, and this enables them to be bound in a volume if required.

COLE'S STUDIES.—Since our last notice, the following subjects have been issued:—

No. 42. White Syenite, from Lairg, with plate and description.

No. 43. Transverse section of the œsophagus of dog, injected and stained with logwood.

No. 44. Transverse section of the stem of *Ribes nigrum* (Black currant).

No. 45. Transverse section of the cardiac end stomach of dog, stained with logwood.

No. 46. Transverse section of the leaf of Scotch fir.

No. 47. Section of the stomach of dog, Pyloric end.

No. 48. Section of Porphyritic Basalt, from the Lion's Haunch, Arthur's Seat, Edinburgh.

No. 49. Contains no plate, but notice is given that it will appear in No. 51.

PETROLOGICAL AND PATHOLOGICAL STUDIES.—We beg to remind our readers that Mr. Cole's above studies are announced only to appear if 150 subscribers for the former and three hundred for the latter, can be found, and therefore we urge every microscopist who cares even the slightest for these studies to send in his name at once to avoid delay in the publication. We cannot do better in this connection than to quote the following from the Journal of the Royal Microscopical Society:—"Microscopists have long lamented that it was not possible to obtain a guide to the slides sold, so that the points of interest illustrated could be intelligently appreciated.

Now that this is provided, it is to be hoped that they will bear in mind that something more is required than 'moral' support in order to ensure a continuation of the series. So many useful ventures have failed through microscopists trusting to their neighbours to provide substantial support, that it is necessary to urge that every one who believes in the value of Mr. Cole's enterprise will himself subscribe to it. No more profitable return can, we are sure, be found for the small outlay required."

LIVERPOOL MICROSCOPICAL SOCIETY.—The third meeting of the fifteenth session was held at the Royal Institution on Friday, March 2nd.

Rev. H. H. Higgins exhibited a specimen of *Fungia Coral*, one of the very few corals that possess the power of locomotion. He also stated that about seventy slides of various Polyzoa had been sent to the Museum, which number he hoped would be soon further increased, the collection affording a good opportunity to microscopists for naming their specimens.

The paper for the evening was read by Mr. J. Michael Williams, on "The Distribution of Lime in Nature," illustrated by original drawings on glass, and shown by the oxy-hydrogen lantern.

The paper described the general character of the earth's crust as classified by the geologist into igneous, or fused rocks—sedimentary, as the result of igneous formation—and metamorphic, or such as have been changed in structure since their deposition, and showing that limestone among the sedimentary rocks, beginning from the earliest periods or systems, is the most important and widely distributed. The general appearance and chemical constituents of limestone were then referred to in the various groups into which the sedimentary rocks have been divided, such as the primary, secondary, tertiary, &c., together with their several divisions into the Laurentian, Carboniferous, Oolitic, Pliocene, and Eocene systems; each system showing, by microscopical examination of their sections, that their structure consisted almost entirely of the remains of organic life, and that the whole group was the result of vital energy. The rhizopod type of animal life, the group foraminifera, was shown to be the greatest participator in this, and that the same agencies that formed the chalk of our surface beds is still performing similar work on the bed of the ocean (as evinced by frequent examination), whether eventually to harden into limestone rocks or through the agency of heat to be crystallized into white marble, time alone can reveal.

The different salts of lime were then traced, as in the formation of bone, and in the crystallized deposits within the tissues of plants, and in the use of the carbonate principally by marine animals represented by some of the polyzoa and zoophyta. Mr. Williams

then described the constant wear on the surface crust of the earth, principally by the action of water, as being something enormous; limestone contributing its quota to swell this removal, and shewing that by analysis carbonate of lime constituted rather more than 50 per cent. of this earthy matter.

The structure of the shells of the mollusca was shewn, and also the structure and habits of some peculiar creatures belonging to the echinodermata; the paper closing with a minute description of probably the most wonderful piece of mechanism which in the economy of its nature has recourse to lime for the purpose of forming its covering with a hard shield—the "Echinus."

The meeting concluded with the usual conversazione and exhibition of microscopical objects.

MOUNTING WITH WAX CELLS.—In mounting "dry," I have invariably found a large proportion of my preparations spoilt from one or other of two causes.

The most difficult one to contend with was the running in of the cement used to fasten the cover-glass and seal the slide up. The other cause was the dampness often shewn after every precaution had been taken to have both object and cell thoroughly dry before applying the cover-glass.

After trying every receipt I could find, I determined to try an idea of my own, and which, after many months' use, has answered the purpose remarkably well. No doubt others have found the same difficulties, so I am tempted to give my experience.

I found a remedy for running in; it was invariably with a cement that caused the dampness, and *vice versa*, so I determined to bring wax to my aid. My process is to get a spirit lamp and place it under a dish supported on a retort stand. Into the dish I pour white wax or bees wax, and melt it. It requires making very hot, and the lamp to be left continually under the dish. If the slide is to be opaque, I cut a piece of black paper to about the size of the cell to be made, and attach it to the slip. I then put it on the turn-table, and build up the cell with the hot wax. Of course it is allowed to overlap the paper background and the glass, and thus make a neat cell. It has the advantage of being built up to any thickness at once. There is also no untidiness of the paper not fitting the bottom of the ordinary vulcanite cell, or if it is placed on the undersides of it, being scratched off. Then again, if the background is put at the back of the glass slip, it is invariably bright instead of dull. When the slide is dry and ready for sealing up, all that is necessary is, place the cover on it and put it once more on the turn-table, when one turn, with the application of the wax brush, is sufficient to make it a permanent mount. It can then be finished with the usual varnishes.

I have described it for opaque dry mounts, but the process can be equally well used with transparent dry mounts. I also use the wax to help to fill up the sides of balsam cell mounts, between the closing cement and the finishing varnish.

In adopting this plan, the wax must be kept very hot, and the brush should be left in it when not in use.

I have never seen this process described, but since I found it out I have told many of my friends of it; they have all found it a great success.—JNO. E. FAWCETT.

LIVERPOOL MICROSCOPICAL SOCIETY.—We are writing with the Fourteenth Annual Report of this Society before us, and congratulate the President and Council upon the very interesting subjects brought before the Society during the past year. The catalogue of the contents of the Society's cabinet and of the books in the library show that the young student in Liverpool has many aids, denied to him residing in less favoured localities. Let us hope these advantages will be appreciated.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the usual monthly meeting held on March 19th, Captain Cunliffe in the chair, Mr. James Cash exhibited specimens of *Cinclidium stygium* from Malham Tarn, and read a paper on its history as a British Moss. The species strictly belongs to the flora of Northern Europe and the Arctic regions. It is recorded as growing at two stations in England and one in Scotland. It was first discovered by Hansworth, Greenwood, and Nowell, of Todmorden, during the summer of 1836.

Mr. Cash's paper was full of interest to the Lancashire botanist, including as it did the correspondence of Wilson, Hooker, and the Todmorden artizans on the subject of its discovery.

Mr. Foster exhibited a beautiful and robust form of the British fern *Polystichum angulare.*

THE MANCHESTER MICROSCOPICAL SOCIETY.—MOUNTING CLASS.—A very interesting and well attended meeting of the Mounting Section of this Society was held on Wednesday evening, Mar. 14th, Mr. R. L. Mestayer, C.E., in the chair.

The subjects dealt with were—mounting of the Wasp's head, *Vespa vulgaris* in pure balsam without pressure, by Mr. H. C. Chadwick, F.R.M.S., and the dissection of the Cockroach, *Blatta orientalis*, by Mr. H. P. Aylward.

The various organs of this common household visitant were laid bare by the demonstrator, and their structure explained, also hints as to the method of their preparation and mounting.

RAMBLES.—On Saturday afternoon, the 7th April, the first ramble of the season, in search of pond life (in connection with the Manchester Microscopical Society) took place. By the kind permission

of Robert Hibbert, Esq., who holds the right of fishing and shooting over the estate, given to Mr. Jas. Fleming, the leader of the party; the neighbourhood selected was Bramhall. This estate covers 2000 acres, and is thickly studded with ponds and water courses. The party on reaching Davenport numbered thirty-seven; the weather was splendid and favourable for the pursuit.

Angling in the ordinary way is different to the fishing for microscopic aquatic life. The followers of Isaak Walton require to use rod, line, reel, and bait, and usually eat what they catch. The scientific animalcule fishermen use rod, net, bottle and pocket lens, and the bait lies in the tact and knowledge they possess to discover the whereabouts, and to secure the many objects of their search. To both parties the tramp and the air of the open country are splendid appetisers and nerve invigorators. In both cases, practice makes perfect; but instead of eating their prey, the microscopic fishermen foster and watch, with eager eyes, the small things in nature, which, without the microscope, although so complete and wonderful in themselves, would be absolutely shut out of view.

It has been remarked that "size is no attribute of beauty," and Ruskin observes, "That which we foolishly call vastness is, rightly considered, not more wonderful, not more impressive than that which we insolently call littleness."

The most prolific ponds are those in which vegetation grows plentifully; about eight ponds of this character and the Lady brook were visited, and although the time was far too short, the result of the ramble was quite satisfactory.

In nice fruiting condition were gathered *Dicranum heteromallum*, *Brachythecium rutabulum*, *Phascum subulatum*, and *Fissidens bryoides*; also, *Hypnum cupressiforme*, *Hypnum elegans*, *Lophocolea bidentata*, and *Calypogeia trichomanis*.

The following Microfauna and Flora were found:—*Corethra plumicornis*, Ephemera larva, Larva of Dragon-fly, *Melicerta ringens*, *Hydatina senta*, *Hydra fusca*, *Cyclops quadricornis*, *Cypris tristriata*, *Daphnia pulex*, *Canthocamptus minutus*, The bloodworm, Nais, *Tubifex rivulorum*, *Coleps hirtus*, *Amœba princeps*, *Paramœcium aurelia*, *Stentor polymorphus*, *S. Barretti*, *S. niger*, *Epistylis grandis*, *Vaginicola valvata*, *Dileptus folium*, *Pandorina morum*.

Micrasterias rotata, *Euglena viridis*, *Cosmarium tetrophthalmum*, *Closterium lunula*, *Sphærozozma vertebratum*, *Pediastrum granulatum*, *Tabellaria fenestrata*.

WITHERED LEAVES.—Under this title a very interesting paper was read by Mr. J. W. Fisher before the members of the Ealing Microscopical and Natural History Club, and, since, it has been reprinted by the author for private circulation. It is illustrated with

seven figures, and goes to show that if we only take one shrub or tree, there is enough in that alone to occupy the serious attention of the microscopist for a lifetime, while a common weed from the roadside will be found scarcely less interesting. Mr. Fisher has put his matter in exceedingly good form.

BACK NUMBERS OF THIS JOURNAL.—We have succeeded in securing two complete sets of vol. I. The price, bound in cloth and sent post free, is fifteen shillings. Application for these should be made early, to the Editor.

Only a few complete sets of vol. II. remain in stock.

OBJECTS MOUNTED "OPAQUE" IN BALSAM.—At the last meeting of the Manchester Microscopical Society, Mr. E. Ward presented a communication upon the above subject; we expect to be able to print it in our next issue.

THE OVA OF ROTIFERS IN THE INTERIOR OF VOLVOX GLOBATOR.—Mr. Fleming, of Manchester, has, we understand, exhibited some very interesting specimens of the above. We hope to give a more detailed description later on. They are best seen with a spot lens.

WORKING DISTANCE.—Upon going to press we have been asked to state the working distance of Leitz homogeneous one-twelfth objective. It is 0·015 inch, or equal to that of many dry "quarters" of 110° in air.

OBJECTIVES OF ENGELBERT AND HENSOLDT.—We have lately had a series of these objectives for trial. They were as follows :—

Designation.	Working Distance. Inch.	Real Focal Length.	Aperture.	Angle in Air.
One Inch.....	0.37	0.82	.24	28°
Half „	0.22	0.51	.32	38°
Quarter „	0.05	0.29	.58	70°
One-eighth „	0.03	0.14	.80	106°
One-tenth „	0.01	0.098	.92	133°

The one inch and the one-tenth we were much pleased with.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 30. *JUNE.* 1883.

ON GYRODACTYLUS ELEGANS.

BY HERBERT C. CHADWICK, F.R.M.S.

GYRODACTYLUS ELEGANS is a trematode worm of parasitic habit. It was discovered in Germany by Nordmann, and afterwards described more or less fully by Creplin, Dujardin, Von Siebold, Diesing, Wagener, and Von Beneden.

The discovery of its existence in England was announced to the Linnean Society in the year 1860, by C. L. Bradley, Esq., F.L.S., who found it on the sticklebacks inhabiting the ponds on Hampstead Heath. In 1861, a translation of Wagener's paper appeared in the "Quarterly Journal of Microscopical Science," and in the following year, 1862, a short paper by Dr. Spencer Cobbold appeared in the same journal, in which he stated that he had found the Gyrodactylus on the fins of the sticklebacks inhabiting the Serpentine, associated with large numbers of Trichodinæ. I have recently found it on sticklebacks from a pond at Eccles, again associated with large numbers of Trichodinæ. In form, Gyrodactylus closely resembles the common sea-mouse, Fig. 43, being tongue-shaped, the dorsal surface being convex, and the ventral surface being flattened. The average length of the specimens observed by Wagener was $\frac{1}{100}$th of an inch, but the specimens which I have had under observation were larger, their average length being $\frac{1}{75}$th of an inch. The anterior extremity of the animal is divided by a median fissure or cleft into two cephalic lobes, Fig. 43 *d*; the cleft passing into a shallow groove on the ventral surface which leads to the mouth *m*. The posterior extremity expands to form the caudal disc, *c d*.

This organ is convex above and concave below, its broadest part being near its junction with the body. In the centre of its ventral aspect two hooks, *h*, *h*, closely resembling fish hooks, are placed back to back, the points being directed forwards and slightly downward, each point resting in the centre of a crescentic fold of

the integument. Each hook is provided with a lateral process, *l p*, by which it articulates with an ossicle of crescentic form, *o*, which is also provided with articulating processes, to which the lateral processes of the hooks are applied. This ossicle appears to me to be concerned in the movement of the hooks, but in what way I have not been able to discover. Between its extremities, which are sometimes truncated, sometimes pointed, an apparently fibrous band may sometimes be seen. The margin of the disc is produced into sixteen processes, each of which carries at its apex a hooklet, *h 2*. Each process, with its hooklet, is individually motile, the movement being effected by means of a linear tendinous appendage, *t*, which originates in the central portion of the disc, on its dorsal surface, and is inserted into the base of the hooklet. The hooklets are provided with two wings, to one of which the appendage is attached. Careful focussing of the microscope reveals a number of fine fibrils, which, in the central portion of the disc, are longitudinal, and are probably muscular. Attached to its finny host by the caudal disc, the animal may often be seen restlessly moving to and fro apparently in search of food. At one moment it is elongated to three or four times its ordinary length; at another it is so much contracted as to appear almost spherical. Locomotion is effected by means of the cephalic lobes, which possess considerable prehensile power, and the caudal disc. The body is first elongated considerably, and, the cephalic lobes being made to adhere to some fixed point, the caudal disc is brought up close behind, the body being thrown into the form of a loop. I am not aware that this parasite has been found upon any freshwater fish except the stickleback in this country, but it was found upon the gills of pike, carp, gudgeon, bream, Prussian carp, minnow, bleak, loach, and pond loach by one of the Continental observers. I have occasionally seen a stickleback make frantic efforts to rid itself of its tormentors, though I have known several to live for two or three weeks with a number of the worms on their fins and tails, without appearing to suffer any inconvenience.

I will now pass on to the consideration of the internal anatomy of the animal. The mouth, Figs. 43 and 44 *m*, when closed appears as a transverse slit, but when open it presents an oval or rounded aperture, having a wavy margin. The integument around it is radially striated. It opens almost vertically into a thin walled pyriform pharyngeal sac, Figs. 43 and 44 *p s*. This sac gives attachment to eight finger-like tentacular processes, Fig. 45 *t p*, which can be protruded through the open mouth, when they resemble an eight-rayed star, Fig. 46. The upper portion of the sac is divided into eight cell-like segments, Figs. 43 and 45 *c s*., in the centre of which a nuclear body, containing a dark nucleolus may be seen, the surrounding contents being finely granular. At the junction

of the sac with the short œsophagus, which appears to occur upon its posterior wall, I have frequently seen an organ which bears considerable resemblance to the mastax of the rotifera, Fig. 45 *m x*,

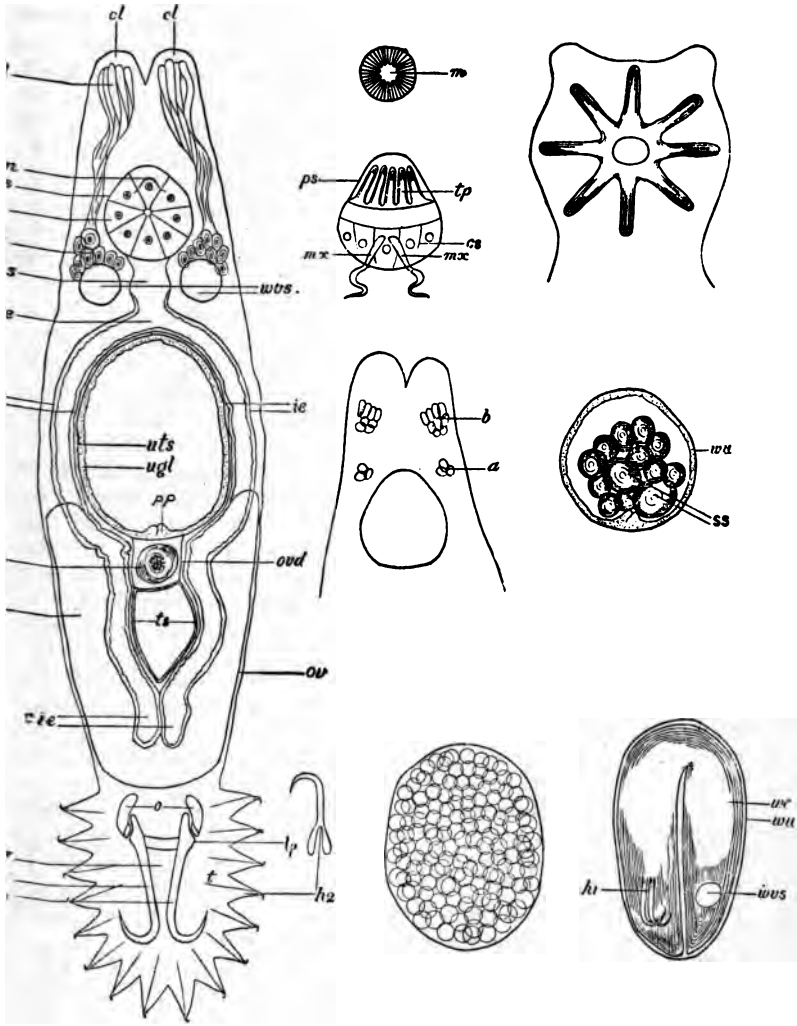


Fig. 43.

Fig. 44.
Fig. 45.
Fig. 47.
Fig. 50.

Fig. 46.
Fig. 49.
Fig. 51.

which appears to have been overlooked by previous observers. In the specimens which presented it most favourably for examination it was composed of two knife-like blades working laterally, and coming in contact with each other by their points only. Outside the wall of the sac, the blades pass into handles in the form of the letter S. The blades, of which there are sometimes three on each side, appear to me to correspond with the mallei of the mastax of the rotifera, the handle being comparable with the manubria. The short œsophagus is somewhat dilated about the middle of its length, Fig. 43 *œ s*, and passes into the intestine, *i e*, which dividing into two branches immediately in front of the uterus, *u t s*, passes along its sides, just beneath the dorsal surface, and terminates cœcally, the ends of the two branches being applied to each other, *c i e*, and resting on the ovary. The intestine is composed of two layers, the outer one being thin and structureless, the inner being much thicker, and consisting of ill-defined and granular cells. On either side of the pharyngeal sac a group of cells, very variable in number and size, are situated, Fig. 43 *u g*. These are the so-called unicellular glands. Each cell possesses a nucleus and nucleolus, and from each a filamentous duct passes to the cephalic lobe of the same side, where it becomes much dilated, *f d*.

The ducts are irregular in thickness, and are bound together in a spherical bundle. Wagener states that these glands secrete a yellowish oily fluid, which may sometimes be seen exuding from the ducts which open upon the cephalic lobes. Two much smaller groups of cells may often be seen on either side; one, containing three or four cells being situated close to the anterior border of the pharyngeal sac, Fig. 47 *a*, the other occurring at the base of the cephalic lobe, and containing from six to nine cells, *b*.

In contact with the unicellular glands, on either side of the œsophagus, there is a spherical contractile sac, containing a clear fluid, Fig. 43 *w v s*. In some specimens only one sac is to be seen, while others possess more than two, all of which may be situated on the same side of the body. The two sacs always contract at the same moment, frequently when the animal is moving actively, less often when it is at rest. Contraction is accompanied and apparently aided by a spasmodic contraction of the surrounding tissues, and results in complete obliteration of the cavity of the sacs. In a few seconds they become fully dilated again, and remain in this condition from one to three minutes.

Up to the present time I have not succeeded in tracing any connection between these sacs and any other structures, but they probably form part of a system of vessels described by Wagener, consisting of four principal trunks lying in pairs on either side of the body, near the ventral surface, and a number of minor branches, some of which are ciliated. These vessels contain a clear fluid.

Nerves have not as yet been discovered, and this species is remarkable for the absence of the four so-called eye spots which have been observed in every other species of the genus. The ovary is a large organ of somewhat crescentic form, occupying the posterior third of the length of the animal, Fig. 43 *o v*. Its blind end appears to be occupied by a mass of protoplasm, containing nuclei, but not divided into distinct cells. As the oviduct is approached distinct cells are found, consisting of a conspicuous nucleus, containing a nucleolus, and surrounded by a layer of protoplasm. These are the young ova. A mature ovum, such as may frequently be seen in the oviduct, Fig. 43 *o v m*, and Fig. 48, is generally more or less oval in form, and consists of finely granular protoplasm,

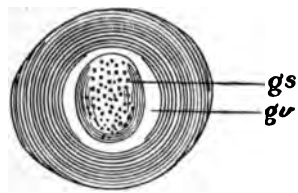


Fig. 48.

containing a large, clear nucleus, now called the germinal vesicle, and a darker granular nucleolus, the germinal spot.

In many Trematodes an accessory organ, known as the yolk gland, assists in the formation of the ovum, and I am inclined to think that such an organ exists in a rudimentary form in Gyrodactylus, but I am not yet in a position to speak positively on this point.

The oviduct is a short, wide tube, Fig. 43 *o v d*, opening into the uterus upon the posterior border of that organ. It is bounded laterally by the branches of the intestine, and is partially overlapped by the testis.

The uterus, Fig. 43 *u t s*, is rounded in form, and occupies nearly the whole of the middle third of the body. In the absence of an embryo, its cavity is filled with a clear fluid, and its membranous wall, *u t s*, is lined by a thick granular layer, *u g l*, which at the point of entrance of the oviduct forms a perforated papilla, *p p*, through which the ova escape into the uterine cavity.

The testis is a conical or heart-shaped body, Fig 43 *t s*, its base being applied to the upper wall of the oviduct. Its lateral borders, like the oviduct, are bounded by the branches of the intestine. According to Wagener, the *vas deferens* opens upon the upper wall of the oviduct. The spermatozoa are simple filaments. During the past four months I have had Gyrodactylus under observation almost daily, and have only seen two spermatozoa. One appeared

to have found its way into the uterus, while the other was seen moving about in the ovary; but though I have used the best appliances at my command with the utmost care, I have failed to discover either spermatozoa or the cells (spermospores) from which they are derived within the testis.

Wagener describes a male genital armature consisting of a pyriform or sub-spherical sac, the external orifice of which is surrounded in a radial manner by from eight to sixteen hooklets, the points of which are directed towards the orifice. On the bottom of the sac a minute pyriform body, perforated longitudinally, is situated. This is the so-called penis. None of the specimens which I have examined have possessed this organ, and it is

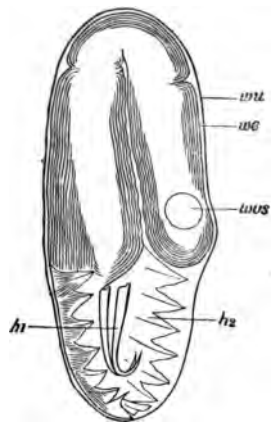


Fig. 52.

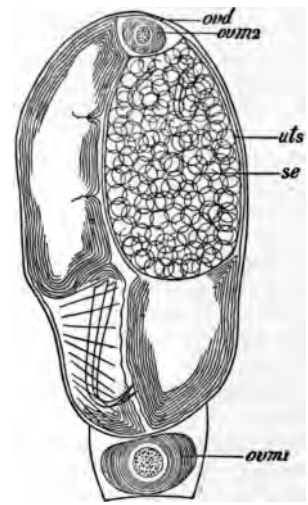


Fig. 53.

markable that Wagener himself confesses his inability to trace any connection between the testis and the penis. The marked absence of spermatozoa in the testis, and the non-existence of the genital armature in all of the large number of specimens examined, has led me to think that the function of reproduction must be performed asexually during the winter months, and that sexual reproduction may possibly occur during the summer. Unfortunately, Wagener does not tell us at what period of the year his researches were carried out. The segmentation of the ovum appears to be extremely irregular and complicated, and I am not at present able to do more than mention a few of the leading features of its development. The ovum at the beginning of segmentation

is a spherical body, occupying nearly the whole of the cavity of the uterus. In the early stages of segmentation, several of the segment spheres are much larger than the rest, Fig. 49 *s s*, but the later stages are characterised by greater uniformity in the size of the spheres, Fig. 50. At an early stage in the development of the embryo the large hooks of the caudal disc are visible, Fig. 51 *h 1*, and, occasionally, one of the contractile vesicles may be seen contracting, *w v s*. A little later, the marginal processes and hooklets of the caudal disc present themselves, Fig. 52, and at a still later period the uterus and oviduct are to be seen, Fig. 53 *u t s*. & *o v d*. This point brings me to the consideration of a remarkable and interesting feature in the embryology of Gyrodactylus. The uterus of the developing embryo nearly always contains an ovum in an advanced stage of segmentation, Fig. 53 *s e*. The hooks of the caudal disc may often be seen, while its oviduct contains a mature ovum, *o v m 2*. The oviduct of the parent also contains a mature ovum, *o v m 1*. Supposing the development of the first embryo to be the result of ordinary impregnation, how are we to account for the development of the second, and in some instances observed by Wagener, of a third. My friend, Mr. C. H. Hurst, demonstrator in Biology at Owens College, to whom I mentioned having seen a single spermatozoon in the ovary, suggested that the ovary may prove to be a hermaphrodite gland, giving origin to both sexual elements. The entire absence of spermatozoa in the testis lends some colour to this suggestion, but I do not think the presence of one spermatozoon in the ovary, which may have been purely accidental, warrants the adoption of Mr. Hurst's view as a means of explaining the development of the second and third embryos; and we must not forget that Wagener records having repeatedly seen both spermatozoa and spermospores in the testis. On the other hand, if the development of the first embryo is proved to be the result of a sexual process, in which the genital armature described by Wagener is concerned, we are still in the dark with regard to the development of the second and third. Wagener suggests that "portions of the first ovum from which the first generation was produced, remain over, which even when contained in the embryo, repeat its formation." If this is the case, what portions of the original ovum remain over; and, as it is perfectly clear that this apparently asexual reproduction may go on indefinitely, at what period in the life history of Gyrodactylus elegans does sexual reproduction take place? These are questions to which I invite the attention of microscopists.

Description of Figures.

Fig. 43. Gyrodactylus elegans—*c l.*, cephalic lobes; *m*, mouth; *c d.*, caudal disc; *h 1*, hooks of caudal disc; *l p.*, lateral processes

of hooks; *o*, crescentic ossicle; *h 2*, hooklets of caudal disc; *t* tendinous appendages of hooklets; *p s*, pharyngeal sac; *c s*, c like segments; *æ s*, œsophagus; *i e*, bifurcate intestine; *c* cæcal ends of branches of intestine; *u g*, unicellular glands; *f* filamentous ducts of unicellular glands; *w v s*, contractile sac *o v*, ovary; *o v m*, ovum; *o v d*, oviduct; *u t s*, uterus; *u* granular lining of uterus; *p p*, perforated papilla of uterus; *t* testis.

Fig. 44. m, mouth, showing ovary margin and surrounding rad striation.

Fig. 45. Antero-lateral view of pharyngeal sac. *t p*, five of t eight tentacular processes; *c s*, cell-like segment; *m x*, mastax.

Fig. 46. Head of *G. elegans*, showing the eight pharyngeal te tacles protruded through the open mouth. The ventral surface the head appeared to be closely adherent to the surface of t stickleback's fin, and particles of food were seen passing throu the pharyngeal sac when this drawing was made.

Fig. 47. Head of *G. elegans*, showing the smaller groups of gla dular cells.

Fig. 48. A mature ovum, *g v*, germinal vesicle; *g s*, germin spot.

Fig. 49. Uterus *w u*, containing an ovum in an early stage segmentation.

Fig. 50. Uterus containing an ovum in an advanced stage segmentation.

Fig. 51. Uterus, *w u*, containing an embryo, *w e*, showing *h* hooks of caudal disc; *w v s*, contractile sac.

Fig. 52. Uterus *w u*, containing an embryo showing *h 2*, pr cesses and hooklets of caudal disc. Other letters as in Fig. 51.

Fig. 53. Uterus containing an embryo, the uterus (*u t s*,) which contains a secondary embryo, *s e*. A mature ovum, *o v m* is seen in the oviduct, *o v d* of the primary embryo. A matu ovum, *o v m 1*, is also to be seen in the oviduct of the paren The oviduct of the parent is in nature partially beneath the uterus its position in the drawing is for the sake of clearness.

THE HATCHING OF ROTIFERS IN VOLVOX GLOBATOR.

By James Fleming, F.R.M.S.

THE white specks frequently seen in the interior of *Volvox globator* are the eggs of the parasite Rotifer, *Notommata parasitica*. After removal from its native water, Volvox, as a rule,

cannot be kept alive for more than five or six days, and this fact prevents continuous observation for any lengthened time; hence t happens these specks often pass away unobserved, and their ıctual nature, for the most part, is undiscovered and unexplained. Early in March the writer collected a quantity of Volvox, and at nce noticed the white specks, usually of a round or oval shape; eing fortunate enough in keeping it alive for eleven days, he was nabled to watch the whole hatching process.

Ehrenberg divides the family of the Notommata into 23 species; wo of them are parasitic,—*N. petromyzon* and *N. parasitica.* He emarks that "the latter class lives in the globes of the *Volvox lobator*, where it deposits its eggs, which are there hatched; and when of a proper age, the creature eats its way through the hollow sphere."

From this quotation it might be inferred that the presence of eggs in Volvox is not an accidental occurrence, but rather a natural and usual circumstance.

These creatures are also found in other Algæ, *viz.*, the *Vaucheria clavata*, as well as in the cells of the Bog Moss. They have a roaming disposition, and are of no settled habitat; their fecundity is enormous, and their power to endure the widest extremes of temperature remarkable.

More frequently, the eggs are found in decaying Volvox, having rents and openings all round; and this condition of the plant favours the view that the eggs have been accidentally washed in; but the writer has seen them in perfectly sound and healthy Volvox, without any breach, so far as could be seen, in the peripheral envelope, and, indeed, he has seen them in the interior of young Volvox whilst yet within the parent sphere.

On the fifth day of observation, the stirring of life in the egg was noticed; and in two or three days more the whole hatching process was completed.

The Rotifer, after living on whatever nutriment there was in the egg, commenced crawling about in worm-like fashion, on the inner surface of the globe; the Volvox, all the time, continuing the usual spinning and rolling motion. Whether the activity and freedom of of the plant is essential to the life of the Rotifer or not, it will be noticed that when the Volvox dies—which is usually very sudden —all observation is terminated, for the house and its tenants are together dissolved and disappear.

On compressing a newly hatched Rotifer chlorophyll grains are found in the stomach, and this may indicate the instinct of the parent in placing her eggs where congenial food was at hand; but *how* the creature "deposits its eggs within the globes of Volvox globator" is a question which requires answering, and is worthy of the attention of all microscopic naturalists. The hatching is best witnessed with a dark ground illumination.

THE BACTERIACEÆ.

By W. Blackburn, F.R.M.S.

THESE micro-organisms or protophytes have been the subject of much controversy of late years, and have often been regarded in very different lights, by botanists on the one hand and physiological experimenters, who are not always botanists, on the other. They nearly all agree, however, in considering them to be some of the lowest forms of vegetable life: to be usually destitute of chlorophyll, a circumstance which separates them from the Algæ, and renders them incapable of utilizing the materials upon which higher vegetable organisms feed, making them dependent upon the assimilated compounds of other vegetable and animal bodies; and they are also considered to be invariably the concomitants, if not the causes, of putrefaction and sometimes of disease. They may be regarded as the lowest forms of micro-fungi, and to consist of two kinds or varieties. In one of these they obtain their nourishment from the organic compounds of decaying substances, and thus fulfil a useful purpose in nature, where they are comparatively harmless, and are called *saprophytes*; in the other kind they derive their nutriment from the organised materials of living bodies, where they are *parasites*, destroying the vital cells of their hosts, and causing disease. According to Prof. von Nägeli, the compounds most readily made use of by these organisms as sources of nitrogen and carbon are albumen (peptone) and sugar, leucin and sugar, and ammonium tartrate, succinate and acetate, and asparagin.

Julius Sachs, in his "Text Book of Morphological and Physiological Botany," divides the Protophyta into those which contain chlorophyll, and have therefore been regarded as belonging to the Algæ, and those which do not contain chlorophyll, viz.: the Schizomycetes (splitting-fungi, the *Spaltpflanzen* of the Germans) which include the Bacteriaceæ and the Saccharomycetes, of which latter the yeast plant is the only well-known member, as the agent of alcoholic fermentation.

The Bacteriaceæ are very small cellular organisms, in which the usual distinction between cell-wall and cell-contents is not observed. The cells are round, oval, or oblong, and the protoplasmic contents are either homogeneous or slightly granular. Sachs says,—"An enormous number of individuals usually are imbedded in a gelatinous mucilage, and this is especially true of the minute forms the investigation of which is hence rendered extremely difficult The growth of the individual cell takes place by the increase of i length; and reproduction, which is asexual, occurs by transve

division and by spores. Sexual reproduction has not been observed; but as it is known to take place in the higher fungi, so also is it possible that in these lower forms, which in some instances contain reproductive corpuscles or spores, conjugation of sexual elements may occur, and their sexual difference being molecular rather than morphological may have escaped observation. The female is at present the only sex known, if these organisms can be said to possess that quality. The cells formed by transverse division in some cases separate from each other, and in others remain attached in filaments. Spores appear in some, and when the parent cells burst the spores are liberated; they then begin to grow in one direction, assume the form of the parent, and have spores of their own. Sometimes in a filament of cells, each cell will contain only one spore; a single cell may in other cases contain several spores. Some forms are stationary, others have the power of motion. In some the motion is produced by flagella, which have been observed at their extremities. In others filaments of one or more cells assume a spiral form, and move either by rotation on their axes, aided in some cases by flagella, or they progress by a lateral movement of the body in rhythmical undulations. Sachs follows Cohn in dividing these organisms into the following four groups :—

1. Sphœrobacteria: very small round cells which separate, forming gelatinous masses on dead organic bodies; often coloured.

2. Bacteria proper: very minute motile cells, rod-like, which impart a milky appearance to putrefying albuminous fluids.

3. Filobacteria: slender cells which remain united in filaments; the latter either straight, as in *Bacillus*, or curved, as in *Vibrio*.

4. Spirobacteria: forming spiral filaments, often much larger than the last, as in *Spirillum*.

This distinction between the Protophytes which contain chlorophyll and those which are devoid of it, although scientifically correct, is not universally accepted, since not only has that substance been discovered in some of the so-called Bacteriaceæ, but some of the supposed Algæ have been found destitute of it; showing that if these organisms are allied to the Fungi on the one hand, they have also some affinities with the Algæ on the other, and especially with the family Oscillatorieæ, the members of which they somewhat resemble in their motions. According to Van Tieghem, the chlorophyll of the two families is not identical, that of the Oscillatorieæ being mixed with phycocyanin, whilst that of the Bacteriaceæ is normal.

Seeing that the life-histories of these organisms have not yet been satisfactorily traced to any great extent, any classification of them in genera must necessarily be only provisional. The following is one suggested by Dr. Luerssen in 1880, which I copy from the Journal of the Royal Microscopical Society of that year :—

A perfectly corrected objective, tested with the test object, and by the mode of illumination above described, ought to show over the middle of the field a clearly defined image of the groups of lines under examination *without any alteration of focus*, and the coloured borders of the separate partial images should not show any other tints than a very narrow edging of pure green, rose, or violet of the secondary colours of a spectrum. Spherical aberration is revealed, when, with the best focussing, the clear lines appear as if immersed in the middle of a broader foggy streak, or when two images, more or less overlapping each other, merge on altering the focus, into one image, somewhat broader and more misty.

A short and ready method of testing approximately any objective is recommended by Professor Abbe, as it is applicable to all instruments without requiring any apparatus except the test object already described. This may be briefly explained as follows:—

First, focus the test plate with central illuminating rays, then withdraw the eye-piece, and turn aside the mirror so as to give the utmost obliquity of illumination, which the objective under trial will admit of. This will be best determined by looking down the tube of the Microscope whilst moving the mirror, and observing when the elliptic image of light reflected from it, reaches the peripheral edge of the field. As soon as this is done replace the eye-piece, and examine afresh the object plate *without altering the focus*. If the objective be perfectly corrected the groups of lines will be seen with as sharply defined edge as before, and the colours of the edges must, as before, appear only as those of the secondary spectrum in narrow and pure outline. Defective correction is revealed when this sharp definition fails, and the lines appear misty and overspread with colour, or when *an alteration of focus* is necessary to get better definition, and colours confuse the images.

A test image of this kind at once lays bare in all particulars the whole state of correction of the Microscope, it being of course assumed that the observer knows how to observe, and what to look for.

With the aid which theory offers to the diagnosis of the various aberrations, a comparison of the coloured borders of the separate partial images, and an examination of their lateral separation and their differences of level, as well in the middle as in the peripheral zones of the entire field, suffices for an accurate definition of the nature and amount of the several errors of correction, each of them appearing in its own primary form. Therewith we also see that which arises from aberration, properly so called (faults of focussing function), clearly separated from such imperfections or anomalies as spring from mere differences of amplification between unequally converged and unequally refracted rays; and, moreover, we eliminate completely all influence of the ocular on the quality of the image.

PHOTOMICROGRAPHY.

[A communication to the Manchester Photographic Society.]

By G. J. Johnson.

PHOTOMICROGRAPHY, or the process employed in photographing the magnified images of microscopic objects, has been practised in France, Germany, England, and America for some years to a more or less limited degree, but of late has received a great impulse from the facilities afforded by rapid gelatine dry plates for the practice of the art by ordinary artificial light. Under the wet collodion system the sensitiveness of the film was too slight for practical use with the lamp or gas, and few cared to encounter the somewhat precarious opportunity afforded in this climate by the happy conjunction of leisure and sunshine. Too often has the writer been victimised when, counting on a morning's holiday and having made all due preparation, the sun has unceremoniously withdrawn his face just as the sensitised plate was placed in the camera, and for weeks together has refused to reappear at an opportune moment.

The finest specimens of the art that I have seen were executed by Dr. Woodward, Surgeon-General of the United States Army, and residing at Washington, who has devoted much attention to the subject, and who evidently has been furnished by the Government with ample funds for carrying out his investigations. His apparatus is of the most complete description, an apartment being fitted up for the express purpose of taking photomicrographs, a heliostat provided, and lenses ground specially by Wales and others for accurate microscopic and photographic delineation. A report, fully illustrated, was published a few years ago by the American Government, containing the results of the labours of this scientist and his coadjutor, Dr. Curtis. Besides portraying such objects as diatoms, the nature of the delicate markings on which has been the subject of so much controversy in past years, these gentlemen have photographed numbers of pathological subjects, which, however, present great difficulties to the photographer on account of the want of penetration in microscopic lenses.

Mr. J. B. Dancer, the well-known Manchester optician, as long ago as 1840, produced photographs of microscopic objects, the image of a flea and other subjects being taken on silver plates.

The first photographic illustrations of microscopic objects published in this country appeared in the *Quarterly Journal of Microscopic Science* in 1853, Vol. I., since which period many works have been illustrated by means of these beautiful prints.

Besides Dr. Woodward, the names of Drs. R. L. Maddox, Aber-

crombie, Wilson, and Redmayne, and of Messrs. Wenham and Shadbolt, have for long been connected with a successful pursuit of the art. A specimen of the work of Dr. Maddox, of London, who photographed the objects delineated in the frontispiece of Dr. Beale's work on the microscope, now lies on the table. Mr. York has also just published a series of transparencies of micro objects suitable for lecture illustration.

I have also prints of diatoms from negatives taken by Fritsch and Müller, of Germany, and published by Williams and Norgate, 14, Henrietta-street, Covent Garden, London. One of the prints is a magnified representation of the set of diatoms so marvellously prepared by Möller, of Schleswig-Holstein, and known as the "typen-platte," or type plate. It contains 100 specimens of these beautiful organisms, which are now classed under the vegetable kingdom, and are found both in a fresh and fossil state over the whole world; for any stagnant pond, running ditch, or seaside pool will afford living examples for the microscopist.

I diverge for a moment from the immediate subject of my paper to describe these peculiar organisms on account of the beautiful skeletons they contain, which form favourite subjects for the photo-micrographer, the valves presenting a flat plane to the focussing-screen, and exhibiting wonderful variety in the sculptured markings on their faces. As a rule they consist of two plates of siliceous material covered with delicate patterns, the plates being held together by a band or hoop of similar material, the whole forming a sort of flat case—in some specimens like a round, shallow snuff-box, and containing protoplasm within. For microscopic purposes the specimens are boiled in acid, and the clean shells mounted dry or in balsam.

These examples of the German photographers, however, do not in any way exceed in beauty the work privately published by my late lamented friend, Dr. Redmayne, of Bolton, whose book of diatom photographs is also here for inspection.

Dr. Woodward, of Washington, has kindly sent me for the purpose of this paper a print of the diatom, *Surirella gemma*, as an example of high magnification and the resolution of difficult markings. Few microscopists, comparatively, succeed with their own instruments in resolving the lines of dots thereon, even with high powers, their resolution being much more difficult than that of the common test object *Pleurosigma angulatum*, to which I have before referred. This photograph was taken with a lens of $\frac{1}{25}$ focus, made by Powell and Lealand, and the magnification is 2,800 diameters, the dots, so plainly seen, each measuring about $\frac{1}{67000}$ of an inch; but I cannot say whether the negative was afterwards enlarged.

Those interested in this subject may find magnificent specimens

of Dr. Woodward's work in the libraries of the Royal Microscopical Society at King's College, and of the Microscopical Society of Liverpool.

Apparatus.—The apparatus employed need not necessarily be expensive. Any small microscope, with fine and coarse adjustments for focussing, and an ordinary quarter-plate camera arranged on a short base board, will serve for a beginner, and even the camera and microscope stand may be dispensed with by the use of a dark box, as described in the *English Mechanic* for February 2nd, 1883.

It is preferable, however, to have a base-board four feet long and eight inches wide, provided with a ledge of wood half-an-inch square on each side, between which a block or carriage may slide, and upon which a bellows camera can be fixed at such an altitude that the flange for the lens will admit the eye-piece end of the microscope, which must be placed in the horizontal position. To allow of a wide field it will be well to have the body or tube cut off about an inch from the nose, and a screw collar arranged to allow of replacement of the tube when it is desired to use the instrument in the ordinary way, or to photograph with the addition of the eye-piece. A short cardboard tube fitting in to the lens flange of the camera will allow of a taper velvet collar two or three inches long being glued thereto, which will serve to keep out the light and yet allow free movement of the object-glass for focussing.

The bellows should possess the greatest latitude of expansion, allowing a variation of length of focus from ten inches to thirty-six inches. The interior of the microscope body should be lined with black velvet to prevent flare on the plate from reflection. When the camera is extended to the full limit, a piece of looking-glass held in the left hand at a suitable angle opposite the ground glass screen will enable the operator with his right hand to focus roughly with the coarse adjustment screw. For accurate focussing a rod passes under the camera, having at one end a knob as a handle, and at the other extremity a pulley one inch in diameter provided with a V groove, in which runs an endless cord working the button of the fine adjustment, also grooved. The rod and pulley should work smoothly to avoid uneven strain on the arm carrying the objective, and the fine adjustment should run sweetly and answer immediately to the least turn of the rod. A mechanical stage with rectilinear motions for carrying the object to be photographed is very convenient, but not essential. The stage plate should, however, be furnished with levelling screws at the corners for bringing all parts of the picture into a flat plane. Both of these appliances are to be seen on the instrument before you.

On the shaft of the fine adjustment screw a short split brass tube half-an-inch long is made to slide stiffly, to which a stout wire pointer three or four inches long is soldered. A semicircle of

cardboard, having its centre coincident with the axis of the fine adjustment screw, is placed behind the pointer, and marked in its circumference with degrees. The split tube allows of the entire revolution of the adjustment screw, whilst the pointer acts as an index through 90° of arc, and records with exactness any slight alteration in focus. The necessity for this will be hereafter explained.

As correct focussing is a most essential point in photomicrography, the finest ground glass is inadequate for viewing the image for final adjustment. The screen is therefore removed, and a lens of short focus, mounted in the middle of a light lath, two inches wide and fourteen inches long, is so adjusted in a short tube that its focus is coincident with the plane of the sensitive film when the

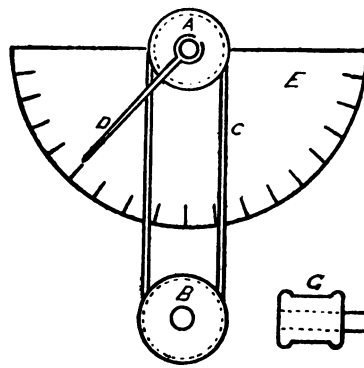


Fig. 35.

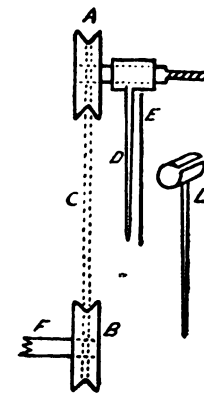


Fig. 36.

lath is held against the back of the camera. This operates as an eye-piece, and the adjusting rod is turned till the picture appears in sharp outline.

At the side of the base-board a scale of inches is marked, measuring from the object carrier, for recording the length of focus employed. Scales of diameter under the respective object-glasses can also be added, showing at a glance the magnification obtained. Thus, at thirty-six inches, it is definitely seen on this instrument that the two-inch objective gives twenty-one diameters.

The chief difficulties to be surmounted by the novice occur under the following heads :—1. Non-coincidence of actinic and visual foci of lenses. 2. Even illumination. 3. Exposure. 4. Selection of suitable objects for photography.

ACTINIC AND VISUAL FOCI.—In photographic lenses by good

makers great pains are taken to make the actinic and visual rays meet in the same point; but as microscopic lenses as a rule are constructed solely for giving the best definition to the human eye, a different formula is adopted for the curves of the glasses. For the sake of your junior members, some of whom may be imperfectly acquainted with optics, you will, perhaps, grant me a short indulgence while I explain the principle of achromatism. [Diagrams were thrown upon the screen illustrative of the construction of achromatic lenses and the over-correction of microscopic objectives.]

As it is generally accepted that the best definition is obtained in photomicrography without the use of the eyepiece, you will at once see the necessity for allowing readily for this discrepancy between the visual and actinic foci. In the instrument before you I have determined by experiment that, when a two-inch object-glass by Baker is employed, the screen being thirty-seven inches distant from the object-screen which has been visually focussed, the objective must be withdrawn $\frac{15}{2000}$ inches, or the rod turned till the pointer previously placed at zero passes through 15° to the right (at half the focal distance $7\frac{1}{2}$° must be allowed). The chemical rays will then make a sharp picture on the film, whilst the outline appears blurred to ordinary vision. In the more delicate corrections required by the higher powers recourse may be had to extension of the bellows instead of altering the fine adjustment screw. The allowance required for each objective can readily be ascertained by placing an ordinary micrometer scale ruled to $\frac{1}{100}$ths and $\frac{1}{1000}$ths inch on the stage of the microscope at an angle of 10° to 15°, so that each line has a varying focal point. On the screen is a photograph of such a scale taken at thirty-seven inches by the two-inch lens, the visual focus having been adjusted at the first line of the thousandths, and the best photographic definition coming out about the fifth or sixth line of the hundredths. The difference in the visual foci of these two lines was represented by 15° on the scale, which was readily found by viewing the scale through the eyepiece and swinging the index between the two focal points. Instead of the micrometer scale an object not pressed too flat—such as a fly which has delicate hairs lying in different planes—may be employed in a like manner.

If a specially sharp picture be required of some difficult object, trial plates should be taken with determinate variations in the length of the bellows, either by cutting a dry plate into slips—which should be numbered and exposed separately—or a diaphragm can be placed immediately behind the focussing-screen, having a revolving disc three inches in diameter fixed in the centre, a quadrant being cut out of the same to allow of successive exposures, the disc being revolved and the shutter lowered between

each variation of the bellows. Four results will thus be exhibited on the same plate.

No tables can be given for the actinic allowance required by the various powers. A one-inch by Dancer, lent by a friend, was found to produce sharp pictures without any such allowance, whilst another by Swift required 2° on my scale. Powers above one-quarter of an inch seldom require compensation, and some of the *photographic* lenses of English make, when stopped down, perform admirably on large objects of a half or one inch in diameter. Many of the pictures to be seen to-night were produced by Dallmeyer's stereoscopic lens, kindly lent by Mr. J. Pollitt. The tyro is recommended to ascertain definitely, once for all, the exact allowance required for each lens, and to keep a careful record of the same.

In order to produce satisfactory negatives no pains should be spared to obtain a flat and even picture, by levelling the object by means of the set screws referred to. I have seen many otherwise commendable photographs utterly spoiled by one-half of the picture being out of focus.

Illumination.—The most preferable source of light, as far as my experience goes, is the sun, but the electric arc, lime-light, gas, and paraffine lamps have all been used. Now that sensitive dry plates are within the reach of all the paraffine lamp is usually employed, either naked or with a bull's-eye condenser interposed. If the latter be employed difficulty is often experienced in obtaining even illumination all over the field, the thickness of the glass breaking up the rays into prismatic colours. Mr. Dancer recommends a double combination quarter-plate lens used as a condenser, an image of the lamp flame being formed thereby a little behind the object, so that the rays just cross before arrival. A disc of light should be produced which amply covers the size of the object. It will be found convenient to ascertain the correctness of the illumination by placing a slip of white writing paper on the object-slide, and observing whether the image of the flame fully envelopes the field. In using the higher powers, when it becomes necessary to obtain more intense light upon a small space the paraffine flame may be placed edgewise. With a good lamp powers up to one-fifteenth of an inch may be employed with dry plates. For low magnifications ordinary daylight from a white cloud will suffice. In using sunlight it is sometimes necessary to interpose a glass cell containing a solution of common alum to arrest the heat rays, otherwise the object or the lens may be injured. With naked sunlight, also, diffraction and interference lines are apt to appear around the image, when a plate of ground glass should be fixed an inch or so behind the object to soften the light. Dr. Woodward, in using very high powers, has sometimes found it imperative to make use of

monochromatic light. This can be obtained by causing the sun's rays to pass through a solution of sulphate of copper to which is added strong ammonia.

In photographing the delicate markings of some diatoms the light must impinge on these transparent objects at a considerable angle, or the direct flood of rays will drown all detail. In photographing the proboscis of a blow-fly I found a superabundance of light fatal to the fine delineation of the false *trachea*. With objects difficult of resolution the ordinary achromatic condenser of the microscope is often employed.

Definition.—In the lower powers definition is rendered much more perfect by the introduction of a stop behind the back lens. For instance: in portraying a section of the stem of the dog rose, a stop a quarter of an inch in diameter materially improved the definition of the delicate cells, and in many histological specimens, where great penetration is required, the tissues being comparatively thick, a reduction of the aperture of the lens is imperative. Stops of cardboard or turned wood may be employed, or Davis's iris aperture shutter, which gives all variations in size from a pin point upwards.

Objects.—All microscopical objects are not equally suitable, on account of either colour or thickness. Tissues stained light blue or purple give faint images, while dense brown objects will not allow light to penetrate the detail. Preparations of insects (such as fleas, which make capital subjects for the beginner) should have lain in the potash solution or turpentine a sufficient time to render the body semi-transparent. Sections of woods, if cut thin and stained a suitable colour, make good pictures. Sections of lung, if thin, give good results, but many anatomical preparations of soft tissues are too thick to allow of perfect focussing with the higher powers. A beautiful section of the retina of the human eye which I possess, although most interesting when viewed in the ordinary microscope, is quite unfit for the camera. Diatoms which present a flat surface, like *arachnoidiscus*, are most suitable, but require careful levelling on the stage.

Exposure.—No fixed rule can be given for exposure, which varies with the light, lenses, and length of focus employed, but much trouble will be avoided by the operator if a standard light be used, and a careful record kept of the results of exposures by means of a register, such as that which lies on the table. With Swan's "ten times" dry plates a small microscopic paraffine lamp without condenser, fixed seven inches from the object, give a good picture in one minute, with a two-inch lens full aperture, and the bellows extended to thirty inches.

As a rule, amateurs over-expose their plates, and produce a weak, thin negative. The movable disc before referred to affords an

easy method of testing the time of exposure, four tests being obtained on one plate. Another method is to partially raise the shutter at intervals, noting the time for each exposure; then to cut the plate down the middle with a diamond, and develope one half two or three minutes longer than the other. Six variations on the exposures can thus be seen, and the utmost novice will be able to discern "which way the cat jumps."

Photographic Process.—If sunlight were always at command I should prefer the wet collodion process, on account of the readiness and rapidity with which trial plates can be developed and examined. Every object differs so much in density or size that the time of exposure is ever varying, and carefully-repeated experiments are necessary. I have heard it stated that Dr. Maddox thought he did well to secure one good negative a day.

Development.—For readiness of application at rare intervals of leisure I have preferred the ferrous oxalalate developer for dry plates, and all my gelatine negatives have been executed so far by this process; but it is doubtful whether this method allows of so much latitude in nursing up the contrasts in a negative of a very transparent object, as is afforded by the pyro. developer. I have also intensified, where requisite, with the saturated solution of bichloride of mercury, and, after well washing, steeping in the solution of ammonia. The solution of mercury may be kept in stock, and used over and over again.

Magnification.—The greater the disparity between the distance of the front lens from the object and the distance of the lens from the sensitive plate the less chance is there of securing penetration or deep focus. Therefore, if large prints are required, better results will follow from employing a low power and taking a small picture, afterwards enlarging from the negative. Quarter-plates will suffice in most instances for this class of work, and those members who have seen Professor Piazzi Smyth's negatives of the Pyramids, only one inch square, and enlarged three diameters by Mr. Pollitt, will be aware how well they bear further magnification on the lantern screen.

The highest resolution I have heard of or seen by photomicrography is that by Dr. Woodward with Zeiss's oil immersion lens one-twelfth of an inch, on the diatom *Amphipleura pellucida*, where the striæ, which in nature count about 100,000 to the inch, are plainly delineated on the print; and Mr. Crisp, the secretary of the R.M.S., tells me the lines have never been so clearly shown by ordinary vision. The nineteenth band of Nobert's test-plate of finely-ruled lines on glass, containing about 100,000 to the inch, was also resolved by this unapproached operator with Tolles' one-eighteenth of an inch immersion lens.

From certain late researches of Professor Abbe the theory is

established that when we are near the limits of "resolution," the superiority of photographic vision, so to speak, over that of ordinary microscopic vision is as five to four, all other things being equal; but it must be remembered that ordinary microscopic powers are constructed for vision and not for chemical portraiture.

The various magnifications obtained by the several powers are set down by Mr. Davis as follows. At thirty-six inches :—

4 in.	= × 12	$\frac{1}{4}$ in.	= × 173
2 „	„ „ 21	$\frac{1}{8}$ „	„ „ 360
1 „	„ „ 37	$\frac{1}{16}$ „	„ „ 530
$\frac{1}{2}$ „	„ „ 80		

Bibliography.—Dr. Beale's *How to Work with the Microscope; Monthly Microscopical Journal:* report by Dr. Woodward, vol. vi., p. 169; *Quarterly Journal of the Microscopical Society*, vol. i., 1853; *Northern Microscopist:* article by G. E. Davis, April, 1881; *Science Gossip*, 1876: article by F. H. Powell; *The British Journal of Photography*, January 26 and February 2, 1883; *English Mechanic*, February 2, 1883.

In conclusion: before we show upon the screen some of the combined work of Mr. Pollitt and myself, allow me to admit that in the presence of such an important Society I feel I have much more to learn than to teach, and I invite your candid criticism of any statement I have made with a view to furthering the development of a most interesting branch of your art, which for some years has been a source of much interest to myself, and is evidently about to become of great educational value.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

SUBSCRIPTIONS FOR 1883. The current year's subscriptions became due in January last. Will those subscribers who have not remitted, kindly do so at once?

BACILLUS TUBERCULOSIS.—Mr. Coppock, in sending out his prepared stains, issues the following directions for staining and preparing sputum :—

"Obtain fresh sputum, and spread a small portion upon a thin cover glass, dry in the air, place a few drops of the *Magenta and Aniline* Stain in a watch glass and float the cover glass, sputum

downwards, upon its surface for thirty minutes, then wash in dilute Nitric Acid (1 to 3) until all perceptible colour is removed. Wash in distilled water to remove all trace of acid. Float again, sputum downwards, upon a little of the *Chrysoidine* stain, wash in distilled water, then immerse in absolute alcohol to remove all trace of water.

The preparation is now ready for mounting permanently, and a drop of liquid Canada Balsam may be placed upon the cover glass and then laid carefully upon a glass (3 by 1-in.) slip, and the spirit in the Balsam allowed to evaporate, or if wanted for immediate examination a little shellac may be run round the edges of the cover glass."

MANCHESTER MICROSCOPICAL SOCIETY.—The annual meeting of the Manchester Microscopical Society was held on Thursday, Feb. 22nd, at the Mechanics' Institution, Princess-street, under the presidency of Mr. William Blackburn. The report of the committee for the past year, which was read by Mr. C. L. Cook (the honorary secretary), stated that the members of the Society now number 214. The ordinary meetings had been well attended, and papers regularly read. The mounting-class and the rambles had been more than usually successful. After the officers and council for the ensuing year had been elected, Mr. Blackburn delivered an address, in which he stated that he had been very unwillingly pressed into the service. It had been the unanimous wish of the Society that Mr. Davis, well-known as the editor of THE MICROSCOPICAL NEWS, should have been president for the year, but Mr. Davis, in consequence of his numerous engagements, did not see his way to add to his responsibilities, and, therefore, under these circumstances, he felt bound to accede to the wishes of those (especially Mr. Davis himself) who were desirous that he should occupy the chair for the year.

Mr. Blackburn, in his address (to be found as this month's leader) spoke of the influence of microscopical research on the progress of natural science and on our well-being, and concluded with an epitome of the recent researches on the septic and pathogenic organisms, and the rational explanation they afford of the sources and communicability of infectious and contagious diseases.

CARLISLE MICROSCOPICAL SOCIETY.—A meeting of members of the Carlisle Microscopical Society was held in the Young Men's Hall, Fisher-street, on Friday night, when a paper was read by Dr. Hall, vice-president, on "*Trichina spiralis.*" Mr. W. Brown was to have prepared the paper, but through the pressure of his professional duties was unable to do so, and the subject was kindly taken up by Dr. Hall. In speaking of Trichinosis he said:—The disease could be clearly made out after death in cutting up the carcase;

for in a very large percentage of the cases of trichinoid pork, the knife in passing through the flesh would be almost sure to encounter gritty particles, which consist chiefly of phosphate of lime and are formed round the cysts of the trichinæ. Mr. Hall further observed that speckled hams bearing the appearance of trichinous disease were to be found, and he related an instance in which a large dealer had been threatened with an action for selling trichinous ham, the appearance of which was in reality due to the peculiar formation of the mildew or fungus arising through the hams being kept in a damp place. Officers who had undergone examinations in the use of the microscope were appointed on the Continent to examine all pork before its sale. They were rewarded for every specimen of trichina they found. Sometimes vinegar eels were mistaken for the mature sexual trichina. Mr. Hall exhibited several specimens of the disease both in the human subject and in pork; also various illustrations.

THE GERM THEORY OF PHTHISIS VERIFIED.—We have received a brochure of 94 pages, bearing this title; it abounds with figures and statistics, and will doubtless prove valuable to the advanced ranks of the medical profession. Its author is W. Thomson, F.R.C.S.; the Publishers are Messrs. Sands and McDougall, of Melbourne.

HEMIDINIUM NASUTUM.—Mr. Bolton has been sending this little organism from his studio during this month. It was found in a ditch in Sutton Park, amongst decaying leaves.

THE WASP AND HONEY BEE.—At the usual fortnightly meeting of the Manchester Field Naturalists Society, a lecture was delivered by Mr. J. F. Robinson, of the Owens College museum, "On the Anatomy and Economy of the Honey Bee." The *Manchester City News* makes Mr. Robinson to say, "the wasp can sting any number of times without sustaining any injury, while the bee's sting being barbed at the tip, when once it is inserted in the skin cannot be withdrawn without causing the death of the insect."

We rather think that if our readers will examine the sting of the wasp, they will find it is "barbed at the tip" also.—ED.

ÆCIDIUM OR PUCCINIA.—In 1881 Mr. Plowright, with an unbiassed mind, set to work to find out whether there was any connection between Æcidium and Puccinia. His experiments consisted in infecting young wheat plants with the spores of Æcidia and comparing them with similar uninfected plants. No definite conclusion was arrived at, as both infected and uninfected plants developed forms of Uredo.

In the following year (1882) Mr. Plowright succeeded in cultivating Æcidium from *Puccinia graminis*, and from the spores of

these Æcidia he produced Uredines as in 1881, but his method of isolating the trial plants was more perfect, and no Uredines were developed on uninfected specimens. Other experiments were made with various forms of Uredo, all tending to the same result, and Mr. Plowright is now perfectly convinced that Æcidium and Puccinia are different forms of the same fungus.

MANCHESTER CRYPTOGAMIC SOCIETY. — The usual monthly meeting was held in the Old Town Hall, Dr. B. Carrington, F.R.S.E., in the chair. Mr. W. H. Pearson exhibited a specimen copy of the Fasciculus III. of the *Hepaticæ Britannicæ Exiccatæ*, containing many new and rare species, amongst which were noticed *Marsupella Stableri*, *Cephalozia Francisci*, *C. æraria*, *C. Turneri*, *Bazzania trilobata*, *Lepidozia Pearsoni*.

Dr. J. B. Wood sent specimens of the two species of *Buxbaumia*, *B. indusiata* and *B. aphylla*, both gathered by himself in the same locality during his visit to the Vosges, Aug. 1872. The *B. indusiata* growing on rotten wood—the *B. aphylla* on the ground. He also sent specimens of *Dichelyma capillaceum* in fruit, from Norway and North America.

POSTAL MICROSCOPICAL SOCIETY.—The Journal of this Society for March commences the second volume. Its price, we notice, has been raised to eighteenpence, which is not too dear for an 8vo 64 page journal, illustrated with 6 plates. Respecting the character of these plates, we must candidly confess we do not like them,—would it not be better to give only 2 plates in each number and have them done well, rather than 6 of a not altogether satisfactory character? We notice the numbering of the plates has been continued from vol. 1. This is a mistake, each volume should be complete in itself.

OTHER JOURNALS.—While on this subject may we venture an appeal to the Council of the Royal Microscopical Society? The first volume is dated 1878 and called Vol. I.; the 1879 vol. is inscribed Vol. II., and 1880 Vol. III. Then in 1881 the title page bears the inscription Series II., Vol. I., and the next year Series II., Vol. II., the 1883 volume will probably be Series II., Vol. III., so that during the past six years we shall have had two inscribed Vol. I., two Vol. II., and two Vol. III. We hope these remarks will not encourage any one to prepare Series III., Vol. I. A further suggestion may be thrown out to the effect that if the Journal grows any thicker it would be well to divide it into half-yearly volumes.

GELATINE AND ALBUMEN PLATES.—Mr. J. T. Chapman, of Manchester, is now supplying these plates for the production of transparencies for the lantern. They are about as sensitive as *wet* plates, and produce exceedingly good pictures when developed with ferrous oxalate.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 29. *MAY.* 1883.

THE ORAL ORGANS OF THE GAD-FLY.

BY J. B. PETTIGREW.

IN preparing a former paper on the Gnat and Mosquito, the interest excited by the examination of the complex oral organs of these insects led me to carry the investigation a little further, and to enquire how far they would bear comparison with those of other blood-sucking Diptera.

The Gad-fly naturally presented itself as very convenient for the purpose, on account both of the size and of the clear definition of its setæ, which render them readily available for microscopical purposes.

Without attempting to point out the differences of structural detail which distinguish the oral apparatus of the various species of the family Tabanidæ, I propose to give a short description of them as presented in the common grey Gad-fly—*Hæmatopota Pluvialis.* Fig. 37 is a drawing done under the camera of the organs of this insect as displayed in a prepared slide and amplified to twenty-one diameters.

We have here a good example of a suctorial mouth, furnished with a full complement of organs, each of which is complete in itself, and is adapted to a special purpose. It will be noticed that the setae are of four distinct kinds. They are all composed of clear amber-coloured chitine, are set closely together, and possess considerable strength and rigidity. The fifth organ, however, the *labium,* is remarkable for its extreme flexibility, rendering it, as we shall see later, capable of traversing a comparatively extensive area. Viewed together, these form a proboscis-like, downward prolongation of the head in a direction at right angles to the axis of the thorax, with a thickened, somewhat bulbous extremity, caused by the position and shape of the *labium;* the setae themselves, when at rest, forming a slender body tapering to a blunt point and resting upon the cavity of the *labium.* Commencing anteriorly, the organ

which first presents itself is the *labrum*, the homologue of the upper lip of mandibulate insects, marked lbr. in figure. This is a straight, trough-like organ, rather longer than the head of the insect —hollow throughout, and having the slides turned over along their margin so as partly to enclose the interior. The base is considerably broader than that of the older setae, but like them the labrum tapers gradually. It terminates in a blunt point, closing in the end. This blunt tip, when examined under one of the higher powers, presents a peculiar structure, which at once suggests the presence of a sense organ. On each side of the upper part of a slightly rounded surface are placed two discoidal plates, studded with papillæ, and having below them a convex body also papillated, but with much more minute papillæ. What is the special function of

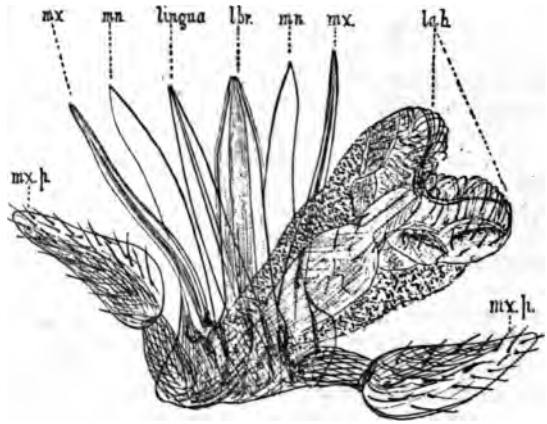


Fig. 37.

these bodies I have been unable to find out; but, taking into consideration their position and structure, it seems very probably that it is sensorial. Running along the middle of each side of the labrum from base to tip is an extremely delicate, flattened ridge minutely fringed at the edge.

The hollow structure of the labrum naturally fits it to be the sheath of the other setæ.

Lying immediately below and on each side of the labrum are the two *mandibles* (mn. Fig. 37). These are long, broad, flattened blades, tapering to a point which is very slightly curved. One of these enlarged to 262 diameters is shown as Fig. 39. The outer edge is seen to be cleanly incisive, and from this the blade appears to become somewhat thicker as the inner edge is approached. This, throughout almost its entire length, is armed with extremely small,

regularly set, saw-like teeth, decreasing slightly in size from the tip towards the base. It is almost impossible to represent these teeth exactly in a drawing, so small are they. According to Gosse, twelve of them are cut in a length of one ten-thousandth part of an inch.

Referring to Fig. 37 again, on each side of the mandibles are found the *maxillæ* (mx.) In structure, these are rather more complex than the former. Of about the same length, they are much narrower, and in place of being flattened, they are thickened into a bayonet-like form, triangular in section, of which the base is widened out. Like a bayonet, too, they bend a little backwards

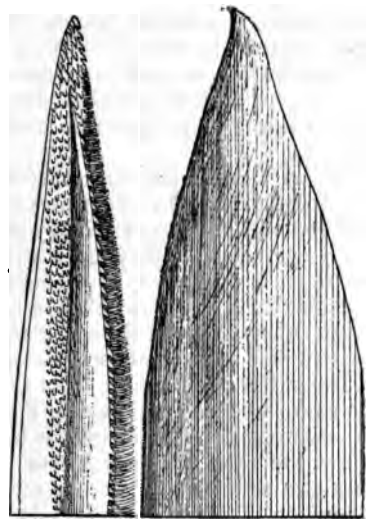


Fig. 38. Fig. 39.

near the point, and present a blunter termination than is found in the mandibles. The maxillæ are also armed with a formidable array of teeth, the arrangement of which is peculiar and rather difficult to describe. Reference to Fig. 38 will here perhaps be of some assistance.

Of the three sides of the maxilla, one is broader than the other two. Commencing at the dilated basal part, this side is found to be deeply channeled, or grooved, quite up to its edges. The groove gradually narrows and becomes less deep in the direction of the tip, leaving thus, on each side, a marginal surface gradually broadening until the groove disappears near the tip. Here there are closely set a number of strong, recurved teeth carried to the extreme point

and edges; at the tip hooked, but lozenge-shaped, where they are continued along the margin in a broadening band which is, however, reduced to a single row of hooked teeth, terminating about the middle of the maxilla. This band does not occupy the entire marginal surface on this side, although it closely borders the edge of the groove. On the other, and, as shown in the Figure on the margin, the teeth assume a longer and more acutely pointed shape in a single row carried along the edge of the grooved hollow to a point rather nearer the head than the termination of the opposite row. Interspersed amongst the teeth on the outer band are numerous short bristly hairs. These merge in a dense, hair-like fringe, carried down the maxilla almost to its base, being longest and finest about the middle third of its length. The Figure is a drawing of the upper third of the maxilla. We have now to consider the remaining seta, the *lingua*, *ligula* or tongue (*lingua*, Fig. 37) described by Gosse as the *labium*, although Burmeister clearly shows that this term is rarely only applicable to the proboscis of the suctorial mouth.

And here I may remark that the drawings, useful as they may be for purposes of illustration, must not be considered as at all a faithful representation of the various organs as they naturally appear. Being taken from a prepared slide, they are necessarily imperfect as regards the true relative position of the parts, and also, to a great extent, in respect of their shape. The mandibles and maxillæ, from their structure and shape, may be little altered, but the hollow labrum and *lingua* and the soft *labium* are necessarily flattened and so distorted. I mention this because, from the appearance of the *lingua*, the organ now under consideration, the mistake might easily be made of assuming for it a distinctly tabular structure. Such, however, is not the case. It may rather be described as resembling in form a thin pointed pea-pod, open to the end along one margin but closed on the opposite side. In the *lingua*, this longitudinal opening is opposite to, and so far corresponds with, that of the labrum already described. That it is used as a suctorial tube may readily be believed; but there can be no doubt that it also serves as an inner sheath for the mandibles and maxillæ, the five together then fitting into the cavity of the labrum. In structure, the *lingua* presents no special characteristics, being throughout composed of hard, clear chitine, and having the two free edges clothed with a delicate fringe, similar in character to, but much finer than, that of the maxillæ.

In passing, a word should be given to the maxillary palpi, one of which is attached to the base of each maxilla. They are two-jointed, the second joint club-shaped, and much dilated at its basal end.

There remains to be noticed the *labium* or proboscis, correspond-

ing to the lower, as the labrum does to the upper lip of a mandibulate insect.

In general character and structure this organ resembles the well-known proboscis of the Blow-fly, and the comparison will perhaps serve better than an elaborate description. It is, however, relatively longer in the stalk, is not bent, but straight, and the terminal divided knob is somewhat differently placed. For some distance from the base it is supported by a chitinous structure analogous to the *mentum*, or chin, which has on each side a membranous flap continued and meeting further on, and at length forming the exceedingly delicate membrane upon which the radiating system of suctorial semi-tubes is arranged. The outer surface of the membrane is thickly covered throughout, with the exception of the region of the tubes, with peculiar very short hairs arranged in groups, *not singly*, as is usual. That is to say, each minute hair, in place of being separately imbedded in the membrane, is grouped with several others on a common base which seems to project slightly itself above the surface. Near the tip again, are placed a number of strong bristles with well defined basal sockets.

The labium, in fact, partly encloses the other organs when at rest, they lying along its inner surface and between the terminal lips of the knob. According to Burmeister, the terminal lips are in reality differentiated labial palpi.

We have here an apparatus well adapted in all its parts to the purpose; first of all, of reaching the seat of the fluid nutriment necessary to the insect, and then of gathering it up and conveying it to the digestive tract. It should be stated, however, that only the female Gad-fly possesses the full complement of organs described. The male is destitute of mandibles, and I think I am right in saying, of maxillæ also. Far from exhibiting the blood-thirsty instincts of the female, he is of a quiet, retiring disposition, preferring the shade of woods, and for food the juices of flowers.

As to the special function of the different organs, I am unable to say much. Their strength, form, and size enable them to penetrate the skin of most, if not all, British animals with comparative ease. The mandibles are probably first brought into play to make an opening into which the barbed maxillæ can then be plunged to enlarge and tear open the wound. The labrum and lingua seem to enter with the rest, and either by the lingua alone, or by the combined organs used as a tube, the blood is imbibed. The wound caused in this operation is sufficiently severe, but the formidable armature of the setæ fully accounts for the pain and subsequent irritation which accompany the bite.

A question here arises as to the function of the labium, if the lingua, or the other organs combined, must be regarded as suctorial. That it is itself capable of fulfilling a similar purpose cannot be

doubted. Its flexibility is such as to give it a greater range than any of the other organs, allowing it either to operate on a small point or to flatten itself out upon a comparatively large surface.

It is not unlikely that the labium is used, as it is by the male, for gathering up the secretions of flowers, but a possible explanation of its use along with the other organs has occurred to me which is perhaps worth mentioning. The bite of the Gad-fly is so acutely painful that the attention of any animal attacked by it is at once drawn to the punctured spot, and in the majority of cases the insect must be almost immediately dislodged. When it returns to the attack, as it soon does, it finds an accumulation of fluid which has exuded from the wound ready for imbibition by the labium, and it is most probable that the delicate titillating movement of the organ, far from causing any further uneasiness, will tend actually to allay the irritation before set up. An undisturbed and plentiful meal can then be enjoyed, for so long as the blood is prevented from coagulating it will continue to flow from the puncture. Should, however, the insect have been allowed to pursue its operations from their commencement without molestation, the labium, in addition to performing this probable function of soothing titillation, will aid the setæ by appropriating any fluid which may escape them at the edges of the wound.

Last summer I had an opportunity of watching a Gad-fly at work on the back of my hand. I did not attempt to use a pocket lens for fear of disturbing it, but I was nevertheless able to obtain a tolerably good view of its operations. On alighting, it appeared to search about, as well as I could make out, with the labium principally, until a favourable spot was found, then a steadying movement of the whole body took place, down went the head and a sharp pain informed me that the setæ were doing their duty well. At the same time the labium could be felt, as well as seen, playing freely around the spot. This went on for some time, perhaps a minute, until an unguarded movement frightened my guest away, and abruptly terminated an interesting observation. A slight quantity of blood exuded afterwards from the puncture. The insect, however, did *not* return to make use of this, and I was therefore unable to verify my hypothesis. Man is, of course, a very occasional victim, but cattle and horses suffer severely in localities where the Gad-fly abounds. The species whose oral organs have been specially under consideration is amongst the least formidable. Several species of the genus Tabanus possess setæ of nearly twice the length, and the armature of the mandibles and maxillæ is proportionately developed. It is not surprising, then, that cattle should exhibit so much restlessness when in the vicinity of these winged foes, armed as they are with instruments against which even a thick skin forms a very insufficient protection.

NOTES ON MOSSES.

By William Stanley.

THOSE who have become interested in Mosses from the previous notes appearing monthly since July last will doubtless have felt a disadvantage in the system pursued when wishful to refer to any particular species; this disadvantage is considerably increased when we remember that at least one-sixth of the British Mosses either do not fruit in the United Kingdom, or that the production of capsules and spores is very doubtful. The remaining species as yet not referred to will, therefore, be taken in the order of their classification, and I would here mention that the London Catalogue of British Mosses and Hepatics, published by D. Bogue, price 9d., will be found extremely useful for the purpose of an index, while it also shows the comparative rarity or frequency of each species by means of a census indicating its distribution through the eighteen Watsonian provinces of Great Britain.

The family Andreæaceæ, named by Ehrhart in honour of his friend J. G. R. Andreæ, an apothecary and naturalist of Hanover, has only one genus Andreæa, consisting of eight species according to the London Catalogue; but Dr. Braithwaite, in his recently published monograph of this family, gives five species only, two having leaves nerveless, and three with leaves strongly nerved. *Alpestris* is considered a variety of *petrophila* and *grimsulana* or *frigida* and *falcata* varieties of *Rothii*. The Andreæaceæ are entirely confined to granite or slate rocks and boulders, and to mountains, stony regions, or the high latitudes of the Arctic and Antarctic zones, and this, no doubt, accounts for the great uniformity in their structure; their habit and valvular bursting of the capsule resembling that of the Jungermannia amongst which they were placed by the older authors.

They are acrocarpous Mosses of a reddish-brown or black colour, growing in small dense fragile tufts. Capsule ovate-oblong and sessile on the elongated sheath (vaginula) at the base of the fruit stalk, splitting into four rarely six or eight valves united at base, and also at the apex by the adherent lid, mitriform, torn irregularly.

Male inflorescence gemmiforme. Stems rigid or slender, forked, or with the leaves collected in small bundles on short branches (fasciculate). Leaves in five or eight ranks, patent, secund, smooth, or papillose, nerved or nerveless; ovate-lanceolate or subulate; the cells minute and thickened, rectangular at base, dotted or angular above.

* Leaves nerveless.

A. petrophila, the rock Andrea, with its beautiful brown or black

cushions, forms a conspicuous object on the rocks in mountainous districts, and so slightly attached at the roots that it is but seldom good herbarium specimens can be procured. Stems cæspitose, ½-1 in. high, nearly erect, simple, or forked. Leaves crowded, nerveless, varying much in form, direction and texture, from an erect base; ovato or oblongo-lanceolate. Areolation dense; the cells strongly and obtusely papillose at back. Capsules small. Male flowers on distinct branches with three concave, broadly ovate and pointed bracts. Fruiting from June to August. Fig. 40.

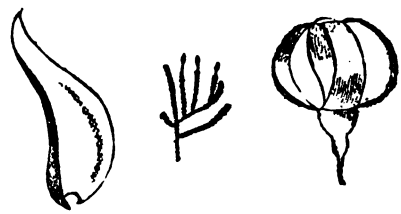


Fig. 40.

Five varieties of this species are found differing in colour, form, and direction of the leaves, but the cell structure exhibits great uniformity. The pale colour of the base and neck is also very marked in this plant.

A. alpina, the alpine Andrea, is common with us on mountain rocks, but it is utterly unknown on the Continent, with the exception of a few stations in Norway. The European species not found in Britain are *A. papillosa* from Spitzbergen and Lapland, and *A. obovata*, *A. Hartmanii*, and *A. Blyttii*, all three confined to Scandinavia. *A. alpina* fruits in June and July, and has erect, much-branched stems 1-3in. high, naked at base. Leaves nerveless densely crowded, smooth, glossy, obovate, and contracted a little below the middle, the margin obtusely serrate above the base, but entire in the upper part where the areolation is in parallel rows and dot like. Capsules oblong-ovate, black-brown, on a dark pseudopodium.

Two varieties of this Moss are found, β *compacta*, in densely compact tufts of a lurid blackish purple colour; λ *flavicans*, elongated filiform stems, the leaves more distant, and colour yellowish.

* * Leaves nerved.

A. Rothii, the black falcate Andrea, grows in black tufts on mountain rocks. Stems ½-1in. high, rigid, forked, and naked at base. Leaves patent, falcato-secund, nerved from an ovate base, lineal-lanceolate, smooth, entire at margin, nerve prominent at back, but vanishing at apex: areolation minute and dotted.

Capsule oblong-ovate, black-brown, pale at base. Male inflorescence gemmiform. Fruiting June and July. Three varieties of this species are found. β *frigida*, plants more robust; γ *hamata*, leaves rather lax and glossy; δ *falcata*, more slender, back; leaves falcato-secund from a broadly ovate base.

Closely resembling the last species is *A. crassinervis*. It is readily recognised by the subulate point or excurrent nerve, which is bordered with a single row of cells having the appearance of papillæ when seen by reflected light. Fruits July and August.

While in all the previous species the leaves and perichætial bracts, that is the bracts surrounding the base of the fruit-stalk, show considerable difference in shape, &c., in *A. nivalis*, the tall slender Andrea, they are alike in form. The capsule is also deeply cleft into 4, 6, or 8 valves.

It is a dioicous Moss in soft, blackish green, widely spreading tufts. Stems 3-4in. high, slender, reddish, branches forked. Leaves patent, secund, the lower, smaller ovato-lanceolate; the upper, falcato-secund, acute, densely papillose on both sides; nerve narrowed, and lost in the apex; capsule a little exserted, oblong; calyptra very small, conical. This fine species, fruiting in July and August, appears to attain its fullest development on the Grampian range, its habitat being the higher mountains of Scotland, on dripping rocks, at the limit of perpetual snow.

Found with the typical form on Ben Nevis and Ben Macdhui is a variety β *fuscescens*, with stems more flexouse and flabby, and strongly falcate leaves of a brown colour.

A rather minute plant is the small-mouthed beardless Moss, *Gymnostomum microstomum* with stems $\frac{1}{8}$-$\frac{1}{4}$in. high, and fruiting in spring on banks and in fields.

Weissia crispula, the curly leaved Weissia, is found fruiting in June and July on mountainous rocks, where also is found *Rhabdoweissia denticulata*, the toothed streak Moss.

A very small and pretty series of plants, greatly resembling each other and requiring care to distinguish, is the genus Seligeria, Bristle Mosses, named in honour of the Silesian pastor Seliger. Found growing on rocks; the leaves are in many rows, lanceolate or subulate, nerved, cells minute and quadrate above, large and rectangular at base, sometimes with coloured angular cells, see Dicranum, calyptra cucullate, capsule ovate or globose with a distinct neck; peristome of 16 lanceolate, flat, smooth, rigid teeth, rarely cleft, sometimes none; spores smooth. Inflorescence monoicous.

Distinctly separated from the rest of the species, being without a peristome, is *S. Doniana* or *Donii* Don's bristle Moss. It is one of the most elegant of our minute Mosses, and probably often overlooked from its inconspicuous appearance. Of a gregarious

.d yellowish-green colour, the stems are very short and
Leaves erect, straight, lanceolate-subulate, acute, nerve
ng all upper part of subula; Capsule truncate-ovate on a
: yellowish seta. Fruiting on limestone and sandstone rocks
,ust. *S. pusilla*, the long-leaved bristle Moss, is not uncom-
ɔn damp shady rocks of sandstone or limestone in loose,
, silky, dark-green tufts. Stems $\frac{1}{8}$in. simple or forked.
es lanceolate-subulate, very narrow, acute, faintly crenulate
e, nerve thin vanishing at apex; capsule erect, ovate, teeth of
ɜtome distantly barred; lid with an oblique beak. Fruits in
ɣ and June. Fig. 41.
Closely resembling the last, but with leaves more acutely
ɔulate is, *S. acutifolia*, the variety *B. longiseta* is, however, only

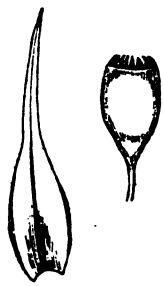


Fig. 41.

Fig. 42.

ɔund in Britain. Found fruiting in May and June in the fis
ɨf calcareous rocks. It derives its name from the longer
ɣhich elevates the capsule above the perichætial bracts; lic
. long oblique beak. *S. trifaria*, or *tristicha*, is a very rare s
ɔund on dripping calcareous rocks, a ready means of identif
ɨeing afforded by the slender branches, which, in the mois
how distinctly the trifarious arrangement of the leaves.
are species fruiting in May and June, and found on c
halk blocks, partially embedded in soil, is *S. paucifoli*
ɹuished by its enlongated capsule. *S. setacea* or *recur*
urve-necked bristle Moss, is found on shady sandstone
tones, fruiting this month and next. It is an olivace
ɣith stems, very short, and fragile, simple or forke
eaves oblongo-lanceolate, upper leaves longly subulat

acute, entire, nerve longly excurrent; calyptra rather large; capsule obovate-elliptical, with a swelling neck, inclined; lid with a straight subulate beak. Also, fruiting in April and May, though much less frequent than the last, being found only on chalk cliffs and calcareous rocks, is *S. calcarea*, the short leaved bristle Moss. Of a dull blackish green, the leaves are short; broad, ovato-lanceolate; entire; nerve flattish and faint, but stronger towards apex; capsule turbinate on thick yellowish brown seta, with a shortly rostrate lid.

The summit of Ben Lawers is the only recorded station for the very rare *Stylostegium cæspiticium*, the minute tufted beardless Moss; while also fruiting in summer, and found in the northern regions, in the fissures of Alpine rocks, is *Arctoa*, or *Dicranum fulvellum*, the brownish fork Moss.

Fruiting in June, and not uncommon on rocks in sub alpine or hilly districts, is *Cynodontium Bruntoni*, Brunton's fork Moss. It bears great resemblance to *Weissia cirrhata* in the foliage. See page 61, but the capsule is more turgid, shorter, and has a very different peristome. *C. virens* is another very rare Moss found on Alpine rocks in the Ben Lawers' province, as also *Dicranella Grevilleana*, Greville's fork Moss, and *D. arcticum*, or *glaciale*. *D. spurium*, the wide-leaved fork Moss, is a very fine species, and is distinguished by its broad tapering leaves. Although fruiting in June, fertile plants are not often found, its habitat being moors and bogs in limited localities. Stems covered with radicular fibres; leaves ovate-lanceolate, acuminate, serrate, papillose on the back; capsule sub-cylindrical, striated, cernuous.

The Leucobryaceæ is a family comprising 65 species remarkable for their pale colour and similarity to the Sphagna in the composite structure of their leaves. They are almost entirely tropical, and our British species *Leucobryum glaucum* is the only representative in Europe. Although common on wet heaths and in woods, the fruit, which ripens from October to March, is very rare. This rarity of the fruit is compensated by there being commonly found on the terminal leaves of the stems of the female plant, a minute tuft of woolly fibriles, developing a cluster of young plants, which, falling to the ground, grow into a new colony.

It grows in dense spongy tufts. Stems 1-6in. high, forked; leaves in thirteen rows, soft, patent; entire, broadly lanceolate, cuspidate with incurved margins. Capsule oval, cernuous, strumose; lid with a long oblique beak. Dioicous. Generic name from λευκος white. *Ceratodon cylindricus*, the narrow-fruited Fork-Moss, found on sandy banks, is not common, and the fruit, which ripens in April and May, is very rare. This Moss is not unlike Dicranum Crispum, but it may be easily distinguished by the sharply denticulate or papillose leaves.

Resembling Dicranum in habit, and with a similar peristome, is the genus *Campylopus*, or Swan-necked Mosses, so called from the capsules being on an arcuate or flexuose, or rarely straight seta; from Καμπυλος curved, πους a foot. They inhabit turfy ground and rocks, and several of the species produce slender flagelliform branches, by which they are propagated.

The leaves are densely crowded, imbricated when dry, erecto-patent when moist, and have a broad nerve of several strata of cells, furrowed or smooth at the back, and frequently terminating in a white hair. A curious falling off of the leaves in several species of this genus is noticeable, same as in Dicranodontium, and is attributed by Lindberg to a change in the contents of the basal cells, akin to the fatty degeneration in animal tissues, the result being the arrest of the circulation through those cells, and their separation from the stem. Calyptra cucullate; fringed at base. Capsules generally striated, deeply furrowed when dry. Annulus of 1-3 series of cells. Dioicous.

C. pyriformis, the dwarf Swan-necked Moss, is not uncommon on heaths and moorlands, and by sides of ditches; fruiting from December to May in large low olivaceous or bright green tufts. Stems ½-1in. high, erect, with radicles at base only. Leaves erecto-patent, lanceolate-subulate; longly setaceous, denticulate at point; nerve ⅓ width of base; furrowed at back; Capsules oval, pale; lid conico-subulate; red.

A plant more robust and leafy than the last, and with fine branched pale radicles on the stem, is *C. fragilis*. It fruits from December to April on sandstone rocks and turfy soil in sub-alpine districts, and is ½-2in. high, of a pale-green, densely leafy above with innovations (extensions of the stem) producing at apex fragile branches with long narrow leaves. Leaves erecto-patent, straight, narrowly lanceolate, very thin and pale at base. Capsule bent down among the leaves, oval, olivaceous; lid, pale red.

A pretty species known by its very compact tufts is found only on the Highland mountains, but not in fruit. *C. Schimperi*. The leaves are erect, straight, lanceolate-subulate, and without the small lobes, (auricles) at the base; nerve ⅔ width of base.

A very rare species, found only in Hebridean Islands, is *C. Shawii*; also rare on Alpine rocks is *C. Schwarzii*, and its minature *C. subulatus* or *brevipilus*.

Fruiting from November to February on turfy ground and moist sandstone rocks is *C. flexuosus*, the rushy Swan-necked Moss. It is seen in dense glossy yellow-green tufts. Stems 1-3in. high, interwoven with reddish fibriles arising from back of leaf at base. Leaves lanceolate-subulate, channelled, serrulate at apex; nerve broad, nearly ½ width of leaf base; occupying all the apex, furrowed at back. Capsules ovato-elliptic, pale; furrowed (sulcate);

lid conico-subulate. A variety *β paludosus*, from boggy heaths in sub-alpine districts is much more robust, 3-4in. high, and with the base of the leaves often tinted with purple.

Two rare species are *C. paradoxus*, gathered on pearly soil in sub-alpine districts, and *C. setifolius*, found on rocks among grass and heath.

C. atrovirens, the bristly Swan-necked Moss, is common on wet rocks and peaty ground on all our mountains, growing in dense dark green silky cushions; stems slender 1-5in. high, repeatedly forked.

Leaves gradually larger towards apex; erecto-patent, lanceolate-subulate; auricled; nerve dilated, ⅓ width of base, sulcate at back, excurrent in a long toothed hoary point. Fruit not found. Fig. 42. *C. introflexus* is a rare species. *C. brevipilus*, the compact Swan-necked Moss, inhabits moist heaths, and is of a glossy yellow green. The stems are slender, fragile, 1-3in. high, with scarcely any radicles. Leaves narrowly lanceolate-subulate, tipped with a short denticulate hyaline point, sometimes wanting; nerve ⅓ width of base; auricles slightly developed. This species differs from all the others in habit and areolation, the upper cells having a distinct S like curve, while the back of the leaf near the apex is rough. A barren and rare Moss is *Didymodon recurvifolious*, the drooping-leaved Didymodon, and found only on the Scotch mountains, *Ditrichum glaucescens.*

D. flexicaule, the wavy-stemmed, is not infrequent on calcareous rocks on the Scotch mountains and in Derbyshire. Growing in glossy yellowish-green tufts with stems 1-3in. high or more. Leaves lanceolate-subulate, concave, denticulate at apex, nerve broad. Capsule erect, ovate-oblong, small, with an amulus; teeth 32, long and unequal. *Trichostomum mutabile*, the variable Trichostomum, frequents moist or shady banks in calcareous soil, and is found fruiting in June and July. Leaves lanceolate or ligulate; spreading, crisped when dry, margain plain; nerve projecting into a slight mucro; capsule ovate; lid rostrate, annulus none.

Greatly resembling the last species in size, &c., is *T. crispulum*, the curly-leaved Trichostomum, but with linear-lanceolate leaves, concave and almost hood-like at the apex; nerve slightly excurrent; capsule erect, regular, oval with an oblique beak; annulus none. Found on limestone rocks near the sea.

Two species not fruiting complete the list of the genus *T. flavovirens*, and *T. littorale.*

Of the Tortulas or screw Mosses, *T. canescens* has only been found near Hastings, Sussex. *T. fragilis* on Ben Lawers, and in Ireland. *T. squarrosa* on the chalk in the south of England and Ireland, and *T. atrovirens*, in March, on dry banks, &c., near the sea.

T. Hornschuchiana, Hornschuch's screw Moss, is found fruiting in April and May on walls and rocks, also on banks in marly soil, and is frequently confounded with *T. revoluta*, growing on limestone walls, from the revolute margins of its leaves, but the leaves are more spreading and more evidently recurved, ovato-lanceolate, acuminate, nerve thinner and more excurrent; capsule longer with a narrow annulus.

Frequent on walls, but very rarely in fruit, is *T. vinealis*, the soft-tufted Screw Moss. Leaves recurved, ovate-lanceolate, with plain margins in the upper half; capsules ovate-oblong, erect with an annulus; peristome short, pale and almost white, with a broad basilar membrane.

(To be continued.)

ADDRESS TO THE MEMBERS OF THE ROYAL MICROSCOPICAL SOCIETY.

By Professor P. Martin Duncan, F.R.S.

(Abstracted from the Journal of the Society.)

EVERY Fellow of this Society who has attended the evening meetings during the last twelve months must have been struck with the very practical nature of our proceedings, and that the observations made, and the apparatus exhibited and described on those occasions, indicated a growing desire for the perfection of the Microscope. At the same time it must have been evident that the application of the instrument to its proper purposes is open to many sources of error, and that there is an amount of intelligence and knowledge required in the management of the Microscope, which is the result of much labour, thought, and experience. Common sense might tell everybody this, but it sometimes happens that when a man has invested a certain number of guineas in an instrument he imagines he is correspondingly endowed with the abilities of a microscopist in the true sense of the term. On the other hand a very large number of able men become possessed of instruments humble in appearance and not costly in any sense, and they rest satisfied that a Microscope is a Microscope, and believe, therefore, that they see the true invariably. One of the benefits of belonging to our Society is the opportunity of seeing objects properly shown by the ablest manipulators, and of hearing communications on the imperfections and corrections of the instrument, and it would be well if our list,

full as it is, were crowded by those scientific men who constantly use the Microscope in original research in biology. A considerable experience impresses me that the majority of students, and not a few professors, not only use indifferent instruments, but also carefully avoid all those practices which we know are absolutely necessary for correct microscopy. A thing is seen, therefore it must be real; one man sees a spiral line, another a circle, another a series of dots, using the same object and different Microscopes. They describe, and debate, and each is self-satisfied. Yet all the while had they had a master in microscopy their differences could be terminated.

A pleasant evening with the Microscope generally means a painful time for the eye. A good glare of light, thanks to lamp, condenser, mirror, and forgotten diaphragm, appears to be almost invariably a desideratum to the beginner. Experience teaches, however, and the advanced microscopist never uses more light than is absolutely necessary, and increases and diminishes the illumination during the careful observation of an object, not only by employing a less intense source of light, but also by using diaphragms of different sizes.

Since microscopy has been extended to the examination of sections of rocks composed of different minerals, the truth that some can be roughly distinguished by their dichroism under the polarizing ray, the analyser not being used, has become apparent. The polarizer is also useful in another manner. Researches have been undertaken to examine into the influence of the polarizing ray upon substances which may or may not give the usual phenomena under the analyser. Polarized light carefully manipulated is very useful in examining thin sections of corals which are made up of closely placed fusiform and long alternating prisms, with geometrical prisms of carbonate of lime in planes one over the other, and often radiating from different points. Shadow and high light succeed when the Nicol is rotated, and minute details become apparent which are not seen, or are only feebly defined, by ordinary light reduced in its intensity to that of the polarizing ray by the use of diaphragms.

Some time since, in investigating the structure of a fossil which was composed of close radiating and occasionally inosculating tubes with very thin walls and a distinct lumen, all mineralized with calcite in the glassy, non-crystalline form commonly seen in fossils where there is much space unoccupied by structure, the polarizing ray certainly made the tubes more distinct than the ray reflected from the mirror alone, and by rotating the substage Nicol, the position of certain tubes which were invisible before could be ascertained; that is to say, dark lines appeared limiting tubes which were invisible under ordinary illumination.

The application of the whole polarizing apparatus is very useful in working at the minute superficial structures made up of thin and highly refractive plates of organic carbonate of lime. The glare of light under ordinary illumination, and even when the polarizer only is used, prevents the true surface being focussed, or if it is fortunately hit upon, it is more or less invisible. But the analyser being placed across the direction of the polarizing ray the true surface can be found by the definition and distinctness of the clear colours and the intermediate lines. Take away the analyser, and often new structures appear to the eye. As a matter of practice I find that this method is exceedingly useful.

Circumstances have brought me in contact with cheap Microscopes, and certainly whilst it may be said that some of the objectives are fairly good, the eye-pieces are on the miserable "par" with the rest of the apparatus. I cannot avoid believing that during the next few years attention will be paid to increasing the merits and adaptability of eye-pieces whatever may be their special character.

In the address which I had the honour of delivering to you last year I remarked upon the comparative values of object-glasses with high and low numerical apertures, and I took pains to defend the employment of lenses with wide apertures in examining minute objects, and also to state that both kinds of objectives are necessary for investigating into the structure of minute objects. I suggested what has commended itself to every advanced microscopist for years past, that an observer should provide himself with both classes of objectives, and that he should use those with a moderate aperture for common and preparatory work, and those with a high numerical aperture for subsequent and careful examination.

Very few microscopists care to correct their objectives during ordinary work, and principally because they have not seen the difference made in the appearance of an object by the process when it has been carefully carried out. But when an object, hitherto unsatisfactorily defined, presents itself under a clear and definite aspect, conversion to the opinion that there is an absolute necessity for correction in all delicate investigations regarding minute structures speedily ensues. There is no doubt that with very few exceptions the microscopic work relating to the morphology of the animal and vegetable kingdom has been conducted either without corrected objectives, or with those which have an average adjustment. I pointed out in my last address how abnormally thick, slender and excessively minute bodies appear under a high amplification; this is partly due to a want of correction, and mainly to another cause which is not necessary to revert to. Now I have no hesitation in saying that similar abnormalities are constantly recorded as truths, and for that same reason which

causes excellent observers to differ in a most remarkable manner about the appearances of the same object under different Microscopes.

It has been put very forcibly by Dr. Dippel that if the shape of the object is unknown, correction may be a mistake, and that when the focus is at a lower plane than the summit of the object, correction may positively mislead.

There is no doubt that an image seen under a certain correction, and which is stated to be normal, is modified by under- and over-correction.

How to get at the truth is difficult, except in the instance of geometrical bodies and definitely parted lines, but the examination of the same object by many observers with different instruments gives experience, and without indulging in calculations, including the method of least squares, it is finally settled that such and such is the real shape.

The possibility of error remains, however, and it is perfectly evident that many a difference of delineation of carefully investigated objects results from non-correction and over- and under-correction. One cannot but help thinking that the difficulties in correcting dry objectives of high amplifying power and great numerical aperture, will lead to the almost constant employment of immersion objectives. And really the only researches which are rendered more difficult by the immersion principle are those which have rendered the name of Dr. Dallinger so illustrious. There is no doubt that it is impossible to prevent the admixture of the medium with the water below the thin cover when minute organisms are followed here and there and often close up to the edge of the glass cover.

Amongst the results of not correcting objectives are want of definition, haziness, and the production of certain colours, and this last phenomenon is often observed in objectives which are corrected up to a certain degree and fixed. It is the fashion to correct and fix so as to obtain a certain amount of chromatic aberration, a ruby tint being considered the best. This is to obviate the effect which the perfect achromatism of a glass of large numerical aperture has on the eye.

There can be no doubt that the majority of the recorded histology of the minuter structures will have to be worked over again with carefully corrected objectives.

In concluding these remarks on the Microscope itself I must enter a protest against the clumsy method of pushing a glass slide with a valuable and important object upon it with the fingers, under the objective and moving it about. Cheapness of the instrument and want of scientific care are the temptations to and the causes of this very frequent source of error, which is intensified

by the common fault of want of perfect flatness of the plane surface of the stand.

The beautiful adaptation of a sliding glass restricted by a point, whilst it relieves the microscopist from the expenditure involved by a complicated brass movement, is so easily fitted that there is no excuse for employing the fingers alone.

THE ACTION OF TANNIN

ON THE CILIA OF INFUSORIA, WITH REMARKS ON THE USE OF SOLUTION OF SULPHUROUS OXIDE IN ALCOHOL.

By Henry J. Waddington.

(Extracted from the Journal of the Royal Microscopical Society.)

I AM desirous of bringing to the notice of the Society a matter which, though small in itself, may be of some use in the hands of experts. The immediate subject is the peculiar action of tannic acid on the cilia of *Paramœcium aurelia;* but I may perhaps, be allowed to digress a little at starting, in order that I may call attention to the methods I have used for keeping Infusoria for microscopical observation.

There are two methods which I have found very useful for this purpose. If small fragments of very hard burnt biscuit are dropped into water containing Infusoria, and held in suspension by pieces of weed or *Confervæ*, these crumbs, after a short time, form a nucleus from which fungoid growths spring freely, so that from a fragment of biscuit 1-32nd in. in diameter we may have a spherical growth of 3-4ths in. in diameter. These growths seem to be peculiarly fitted for the development of certain kinds of Infusoria, and they have this advantage—that when lifted out of the water, the filaments necessarily collapse, and act as a net to inclose whatever may be among them. When placed on a slip, a portion of these filaments may be spread out with needles, and they then serve the purpose of so retarding the motions of the Infusoria that their observation is comparatively easy, the extreme fineness of the filaments allowing the highest powers to be successfully used. It is necessary that the biscuit should be very hard and well baked, otherwise the fragments disintegrate. This method applies to Infusoria in aquaria, or in comparatively large quantities of water; but where they are contained in small troughs, I find that they thrive well on leaves of *Anacharis* or filaments of *Conferva*, which have been reduced to a pulp with a little water

in a mortar. If a few drops of this are occasionally added to the trough containing the Infusoria they may be kept satisfactorily for a length of time. The small trough I have has been so kept for more than four months.

In trying the effect of various chemicals on Infusoria—principally *Paramæcium aurelia*—I was led to use a solution of tannin, or tannic acid; and I was surprised to find that the immediate action of this chemical was to render the cilia visible without any manipulation of the light. It may have been noticed that when these Infusoria have been killed by ordinary means, such as heating the water in which they are contained, the cilia are very difficult to observe, probably owing to their great transparency, so that no correct idea has, I think, been obtained of their size or quantity.

On placing, however, a drop of water containing *Paramæcia* on a slip side by side with a minute quantity of a solution of tannin, and making a junction of the two, it will be seen that the instant the *Paramæcia* approach the mixed fluids their motion is arrested, of course in a greater or less degree according to the strength of the tannin. They are generally rendered perfectly quiescent, and the cilia begin to appear and continue to develope, until the body of the animalcule appears entirely surrounded by them. The symmetry of the cilia depends upon the strength of the solution; if it is too weak, it seems as if the animal had had time to slightly move the cilia, by struggling, as it were, as they appear crossed and crumpled; but if the solution of tannin happens to have mixed with the water in a better proportion, the cilia are more rapidly developed, and stand out almost parallel, hardly one being seen to overlap another.

To bring out the best appearance of the cilia over the whole of the surface of the *Paramæcium*, the parabola is required; the animal then appears as if it were supported on the slip by its cilia.

If the tannin solution is strong the *Paramæcium* is almost instantly rendered motionless, and the cilia appear to be entirely removed, remaining in a more or less confused state at the extremity.

I have shown this action to several microscopists, and so contrary is the remarkable development of the cilia to received ideas, that on nearly every occasion I have been met with the remark that they were not cilia but fungoid growths. This is, however, entirely disproved by the fact that they are developed, as it were, instantaneously.

The action of the tannin on the cilia I believe to be analogous to its action on gelatine, rendering them leathery, and consequently opaque. It does not appear to kill the *Paramæcium* itself—at least for some little time, unless the solution is very

strong, as the rhythmical contraction and expansion of the contractile vesicles may be still observed. In the most successful observations it is probable that the tannin solution has been of sufficient strength to act upon the very delicate cilia, and, as it were, to paralyse them; while it has not been of sufficient strength to kill the animal outright. In the face of the accepted theory that ciliary motion is involuntary, it would be incorrect to say that the tannin acts upon the cilia in such a manner as to render them beyond the animal's control; but the cilia are certainly rendered inert, while the functions of the animal are but little impaired for a time.

The form of tannin which I have found most convenient to use is the glycerole of tannin, which is merely tannin dissolved in glycerine in the proportions of one part to four. It is a thick, viscid body, very stable, easily miscible with water, and consequently very manageable, as the quantity added to the water under examination can be well adjusted, and the action is more satisfactory than it would be if a solution of nearly the same specific gravity as water were used. Tannin in alcohol is not advisable on account principally of the repellent action between the alcohol and the water.

That the immediate action of the tannin in moderate quantity is not to kill the *Paramœcium* is, I think, apparent from the fact that Infusoria much more minute than *Paramœcia* seem to be little affected by it. I have constantly seen these become entangled in the cilia of *Paramœcium* that had been rendered motionless by tannin, and extricate themselves after a time apparently little affected by it. But such Infusoria have not possessed cilia of the same character as *Paramœcium*. On *Stylonychia* the tannin does not appear to have so decided an action, and whenever the cilia take the form of setæ the Infusoria seem much more capable of resisting its paralysing action, the peculiar jerky motion of the setæ being kept up for some time.

I have made the remark that I think no correct ideas have hitherto been held as to the size and quantity of the cilia; at any rate I have never seen any drawing, or read any description of *Paramœcium*, as it is observed after the treatment by tannin. That the appearances observed are really cilia may be easily verified by the action of osmic acid, which kills the *Paramœcium* at once, and renders the cilia visible, but not to the extent that they are so rendered by the tannin.

I may also make allusion to the action of another chemical body on Infusoria, and to the advantages it seems to possess in microscopical research. This body is sulphurous acid, or, in the form in which I have found it most useful, solution of sulphurous oxide in alcohol. The properties of sulphurous oxide are too well

known to require any comment. I will merely mention that it is soluble to the extent of 30 volumes in 1 volume of cold water; but this solution soon changes into sulphuric acid by the action of air. If, however, the gas is passed into alcohol the quantity absorbed is greatly increased. If this saturated solution of the gas in alcohol is added to water, the gas, or the greater portion of it, is instantly thrown off. This alcoholic solution I have found most satisfactory in the observation of Infusoria. When a minute quantity is added to a drop of water on a slip, there is at first the repellent action between the alcohol and the water. This being overcome, the gas is given off, and its effect upon infusorial life is at once apparent. If the solution is strong they are at once killed, and in most cases, if the Infusoria are ciliate, the cilia are rendered visible; but if the deadly solution has been strong enough to be hurtful but not deadly, examination may be carried on satisfactorily. The Infusoria are rendered almost motionless, while the ciliary action may be well observed.

If, under these conditions, the slip containing *Paramœcia* is allowed to become dry, the points of attachment of the cicilia to the body of the animal are exceedingly well defined. Where the cilia have become detached they almost resemble raphides.

I think that this reagent—sulphurous oxide in alcohol—is one that may prove of great use in microscopy. It is not so deadly as osmic acid, but it has a very marked action on Infusoria; while it is by no means so dangerous, and its cost is much less. The solution in water possesses very powerful bleaching properties, and the alcoholic solution, which is perfectly stable, furnishes a ready means of obtaining small quantities of sulphurous acid, for bleaching or other purposes.

I would merely add in conclusion that I consider I ought almost to apologise for dealing with a subject so very foreign to my usual microscopical pursuits. The experiments I have described have been carried out more as a microscopical recreation than as a scientific research; but they have appeared to me, and to those microscopists to whom I have shown them, to be of so much interest, and so capable in the hands of those more conversant with the subject than myself of further extension, that I have been induced to bring them forward.

TESTING MICROSCOPE OBJECTIVES.*

By Dr. Allen Y. Moore.

WITH all the microscopical literature we have, it is surprising to see how little attention objectives have received, and, at the same time nearly every work on the subject tells us that the objective is the most important part of the entire instrument. That this is a fact, I think no person will deny, and if the objective be otherwise than perfect, a knowledge of its imperfections will help the observer by giving him an idea of how far his instrument may be considered trustworthy.

All first-class objectives in which the angular aperture exceeds 75° or 80° in air, should have a correcting collar; and although it makes less difference with the lower powers, the higher ones should be so constructed that the collar moves the back system of lenses.

Bad centering and bad form are conditions which are inexcusable. By bad centering is meant, that the centres of the lenses are not in a straight line. By bad form is meant that the curves of the lenses are not segments of true spheres. Either of these conditions may be detected by what is known as the artificial star. This is nothing more than a very small globule of mercury upon which a strong light is thrown.

If such a globule be placed in the centre of the field and carefully focussed, a bright spot, which is the image of the source of light, will be seen. If the tube be now racked up or down, so as to throw the globule considerably out of focus, it will be seen that the bright spot expands and becomes a large circle of light. If the lenses be truly formed and correctly centered the edge of this circle, or expansion of light, will be true and even, but in case the lenses are not in a straight line, the circle of light, or coma as it is more frequently called, will not be perfectly round but will be seen to bulge more on one side than on the other. Bad form is shown by an irregularity of the outline of the coma, and the shape of the coma will indicate the shape of the curved surfaces of the lenses.

Chromatic and spherical aberration next deserve attention. Chromatic aberration is that condition in which the white light, after having been decomposed by the refracting surfaces of the crown lenses, is not properly recomposed by the proper action of the flints. When an objective brings the violet light to a focus before the red, it is said to be chromatically undercorrected; if the red rays meet sooner than the violet, it is said to be overcorrected.

* Read before the Griffith Club of Microscopy, of Detriot, February 6th, 1883.

With the lower powers the artificial star is about the best test for determining this condition. With the glass now used by opticians for the construction of objectives, perfect achromatism has never been attained; there being at best a secondary spectrum caused by the unequal dispersion of the various parts of the primary spectra of the flint and crown glass lenses. These colors are a pale green and pale violet. If a well-corrected objective be focussed upon the mercury globule, and then brought without and again within the focal point, it will be seen that the circle of light has a colored border, and that when the globule is without the focus this border is of a pale green color, when within it a pale violet. These colors ndicate the best chromatic correction, and any variation will show tself by more or less change in the color. If undercorrection be resent it is indicated by the green taking on a bluish cast, or, if ery much undercorrected, a distinct violet is to be seen. In the lace of the proper violet—that is when within the focus—a reddish iolet, or even a brilliant red, is seen. Overcorrection is indicated hen in the place of the green, a yellowish-green, brilliant yellow, r orange is seen; and in the place of the proper violet, a blue order is seen. This applies, not only to the mercury globule when sed as stated, but to almost any opaque border of an object. With ıe higher powers, a very convenient way is to use a well-marked iatom, or, what in most cases is still better, a strongly marked odura scale. In any such objects as these, the dots or spines ppear violet and the interspacing green when the chromatic cor-ection is right; and in the case of under or over correction these olors give way to the colors already mentioned as occurring with he artificial star.

The correction of spherical aberration is more important than hat of color. By spherical aberration is meant that the rays of ight which pass through different zones of the objective do not nite in one point in the eye-piece. If the peripheral rays meet efore the central ones, the objective is said to be spherically un-lercorrected, while if the reverse be the case, overcorrection is resent. With the artificial star the presence of spherical aberration s shown by the coma, or circle of light, expanding unequally when he globule is placed within the focus, or the same distance beyond he focus. Should the greater expansion of the coma take place when the distance between the objective and globule is increased, the objective will be undercorrected, but when the greater expansion is within the focus, overcorrected.

I have here this evening a one-inch objective with which, by the aid of the artificial star, I shall practically illustrate the appearances seen with a well-corrected glass. The workmanship of this lens is superb, and, although of moderate angular aperture, it is much better in definition and resolution than many lenses of much wider

angle. By the aid of the back system of a cheap English one-fourth-inch objective, I shall illustrate the irregularity of outline of the coma, which indicates a want of true form or curves, of the lenses.

Angle of aperature is of great importance. By this is meant the angular breadth of the cone of light received from the object by the objective. This is to be determined by direct measurement. As convenient a method as any, is by using a stand which has a graduated rotating base, or graduated swinging substage bar. The objective should be put upon the stand and accurately focussed, the stand being in a horizontal position. A lamp is then placed several feet distant, and, by turning the stand upon the base, the aperture is ascertained, the light being allowed to divide the field equally on each extreme of the angle. In case the measurement is to be made by the aid of the substage bar, this may be made to carry a small candle or lamp, which should be diaphragmed to a narrow slit. The measurement, as before stated, should be made from the point at which the light bisects the field. When it is desired to measure balsam aperature, or the angle of the rays in Canada balsam, it is necessary to use the proper immersion fluid, and to have a hemispherical lens placed under the object (the object, of course being balsam mounted) whose centre of curvature is in the plane of the object. The readings upon the base or substage bar then indicate the angle within the hemispherical lens; and if this be of the same glass as the front lens of the objective, the true glass angle, or, as it is more commonly called, the balsam angle, becomes known.

I think it may not be unjust to say that many of the objectives of our best makers will fall considerably short of the aperture claimed for them. A recent $\frac{1}{8}$ for which an angle of 130° in balsam, was claimed, only measured 125°; a very fine $\frac{1}{10}$ for which a 140° was claimed, only gave 116°; and a $\frac{1}{10}$ claimed to have 105°, only gave 97°.

An objective may have a very wide angle of aperture and still be inferior to that of another objective of less angle. In such case the trouble is generally due to a want of proper correction for chromatic and spherical aberration. In measuring aperture it is always well to select some test-object which shall be more or less difficult to resolve with the objective to be measured. It should then be focussed and carefully watched as the stand or mirror bar is turned, until the very best resolution is attained. By increasing the obliquity of the light it may then be seen whether the extreme rays which traverse the periphery of the objective are really of any use. For example, in the $\frac{1}{8}$ already mentioned the light will enter the objective at 125°, but the light which forms the image only enters at 120° hence the objective is no better than one properly corrected having 120°.

Flatness of field and penetration are two qualities of which I can say but little. Many of the best objectives have a very flat field, but I have never yet seen one in which the definition was really good to the extreme edge. It is easily determined by examining any flat, well-marked object, such as a section of echinus spine with the lower powers, and a slide of evenly spread blood-corpuscles with the higher ones.

Working distance is of especial value in high powers. It is the distance of the object from the front lens when in focus. It can only be ascertained by actual measurement. For this purpose a scale and vernier on the ways and the body are very desirable, but I have never yet seen a micrometer screw sufficiently good to correctly measure the working distance of the higher powers. The best way of measuring the greatest working distance is by having a number of cover glasses of various thicknesses, accurately measured, and see which is the thickest that the objective can be made to focus through, using the ten-inch body. It will be found that the actual distance between the object and the objective will increase with an increase in thickness of cover-glass or the density of immersion fluid.

The magnifying power of the objective is a matter well worth knowing. Many objectives are underrated; for example, a recent $\frac{1}{10}$ which I measured only gave 84 diameters at its greatest power, while another $\frac{1}{10}$ gave the unusual power of 120 diameters, thereby being a true $\frac{1}{12}$.

The correct point from which to measure the power, is the optical centre, but as this changes with every change of immersion fluid or length of body, it is not practicable, hence the front surface of the front lens is generally taken as the standard, and the image is measured at a distance of 10 inches from this point. The best way of doing this is by placing a micrometer on the stage and a piece of finely ground glass at the end of the body instead of the eye-piece. The distance of the ground glass from the front of the objective should be ten inches. If the micrometer be now illuminated by very intense lamp light, or in the case of the higher powers by sunlight, and carefully focussed, the image of the lines will be seen on the ground glass. Their distance apart may then be dotted on the ground glass and then carefully measured. If the distance apart of the dots upon the ground glass be now divided by the real distance of the lines on the micrometer, the linear amplification will be the result.

The power of the eye-piece may now be determined from that of the objective. The eye-piece should be placed in the tube, with its field-lens in the case of a negative eye-piece and its focal point in the case of a positive eye-piece, at a distance of ten inches from the front lens of the objective. The power of the microscope

should now be taken at ten inches with the camera-lucida in the usual way. The power of the microscope, divided by the previously determined power of the objective, will give the power of the eye-piece in diameters.—*American Monthly Microscopical Journal.*

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Dav The Willows, Fallowfield, Manchester, before the 16th each month.

SUBSCRIPTIONS FOR 1883. The current year's subscriptions beca due in January last. Will those subscribers who have not re mitted, kindly do so at once?

PICROSULPHURIC ACID is used for killing marine organisms at the Zoological station at Naples. It kills quickly, rapidly replaces the sea water, does not harden, and may be directly replaced by alcohol. It is composed of a saturated solution of picric acid in water, one hundred parts, with two parts by measure of concentrated sulphuric acid. When mixed, filter, and dilute with thrice its bulk of water.

ALCOHOL has been used with much success in mounting *Lophopus crystallinus* with the tentacles expanded, by Mr. H. C. Chadwick, of the Manchester Microscopical Society. The spirit is blown as a spray upon the surface of the water containing the organisms; it mixes slowly, and the tentacles are thereby not retracted.

HOMOGENEOUS OBJECTIVES.—We have lately had an opportuni of examining a $\frac{1}{12}$th homogeneous immersion lens of Leitz; it h a balsam angle of 100° (82° B.A. being equivalent to 180° in air and stands deep eye-pieces very well. *A. pellucida* is shown as lin in its shorter direction, and *Navicula rhomboides* come out beaut fully in squares without any tedious manipulation. The price but five pounds, so that this lens will be found worthy of notice b many microscopists.

GUNDLACH'S NEW LIST OF OBJECTIVES.—We find Gundlach h listed a one-inch objective of 85°, a half-inch of 110°, and als some cheap glycerine immersions, of from 95° to 100° balsa angle.

PHOTOMICROGRAPHS.—Dr. George Sternberg has a work in t

press on this subject which will be illustrated with seventeen heliotype plates from his best negatives.

THE THAMES MUD BANKS.—Dr. H. C. Sorby is busy making a microscopical investigation of the deposits in the Thames. His report will be looked forward to with interest.

MR. BOLTON'S PORTFOLIO OF DRAWINGS.—No. 9 of this series was issued in March last. It contains drawings and descriptions of—

Uvella virescens.	*Anuræa curvicornis.*
Pyxicola affinis.	Leptodora (young stages).
Stichotricha remex.	*Idya furcata.*
Trochosphere of Alcyonidium.	*Haplobranchus æstuarinus.*
Œcistes umbella.	*Ammothea fibulifera.*
Cephalosiphon limnias.	Water-mite *(Atax albidus).*
Melicerta tyro.	Water-mite.
Flosculuria regalis.	Elver, or young eel.

We are glad to notice that the drawings are more uniform in size than heretofore, and this enables them to be bound in a volume if required.

COLE'S STUDIES.—Since our last notice, the following subjects have been issued:—

No. 42. White Syenite, from Lairg, with plate and description.

No. 43. Transverse section of the œsophagus of dog, injected and stained with logwood.

No. 44. Transverse section of the stem of *Ribes nigrum* (Black currant).

No. 45. Transverse section of the cardiac end stomach of dog, stained with logwood.

No. 46. Transverse section of the leaf of Scotch fir.

No. 47. Section of the stomach of dog, Pyloric end.

No. 48. Section of Porphyritic Basalt, from the Lion's Haunch, Arthur's Seat, Edinburgh.

No. 49. Contains no plate, but notice is given that it will appear in No. 51.

PETROLOGICAL AND PATHOLOGICAL STUDIES.—We beg to remind our readers that Mr. Cole's above studies are announced only to appear if 150 subscribers for the former and three hundred for the latter, can be found, and therefore we urge every microscopist who cares even the slightest for these studies to send in his name at once to avoid delay in the publication. We cannot do better in this connection than to quote the following from the Journal of the Royal Microscopical Society:—"Microscopists have long lamented that it was not possible to obtain a guide to the slides sold, so that the points of interest illustrated could be intelligently appreciated.

Now that this is provided, it is to be hoped that they will bear in mind that something more is required than 'moral' support in order to ensure a continuation of the series. So many useful ventures have failed through microscopists trusting to their neighbours to provide substantial support, that it is necessary to urge that every one who believes in the value of Mr. Cole's enterprise will himself subscribe to it. No more profitable return can, we are sure, be found for the small outlay required."

LIVERPOOL MICROSCOPICAL SOCIETY.—The third meeting of the fifteenth session was held at the Royal Institution on Friday, March 2nd.

Rev. H. H. Higgins exhibited a specimen of *Fungia Coral*, one of the very few corals that possess the power of locomotion. He also stated that about seventy slides of various Polyzoa had been sent to the Museum, which number he hoped would be soon further increased, the collection affording a good opportunity to microscopists for naming their specimens.

The paper for the evening was read by Mr. J. Michael Williams, on "The Distribution of Lime in Nature," illustrated by original drawings on glass, and shown by the oxy-hydrogen lantern.

The paper described the general character of the earth's crust as classified by the geologist into igneous, or fused rocks—sedimentary, as the result of igneous formation—and metamorphic, or such as have been changed in structure since their deposition, and showing that limestone among the sedimentary rocks, beginning from the earliest periods or systems, is the most important and widely distributed. The general appearance and chemical constituents of limestone were then referred to in the various groups into which the sedimentary rocks have been divided, such as the primary, secondary, tertiary, &c., together with their several divisions into the Laurentian, Carboniferous, Oolitic, Pliocene, and Eocene systems; each system showing, by microscopical examination of their sections, that their structure consisted almost entirely of the remains of organic life, and that the whole group was the result of vital energy. The rhizopod type of animal life, the group foraminifera, was shown to be the greatest participator in this, and that the same agencies that formed the chalk of our surface beds is still performing similar work on the bed of the ocean (as evinced by frequent examination), whether eventually to harden into limestone rocks or through the agency of heat to be crystallized into white marble, time alone can reveal.

The different salts of lime were then traced, as in the formation of bone, and in the crystallized deposits within the tissues of plants, and in the use of the carbonate principally by marine animals represented by some of the polyzoa and zoophyta. Mr. Williams

hen described the constant wear on the surface crust of the earth, rincipally by the action of water, as being something enormous; imestone contributing its quota to swell this removal, and shewing hat by analysis carbonate of lime constituted rather more than 50 er cent. of this earthy matter.

The structure of the shells of the mollusca was shewn, and also he structure and habits of some peculiar creatures belonging to the chinodermata; the paper closing with a minute description of robably the most wonderful piece of mechanism which in the conomy of its nature has recourse to lime for the purpose of form- ng its covering with a hard shield—the "Echinus."

The meeting concluded with the usual conversazione and exhibi- ion of microscopical objects.

MOUNTING WITH WAX CELLS.—In mounting "dry," I have in- ariably found a large proportion of my preparations spoilt from ne or other of two causes.

The most difficult one to contend with was the running in of he cement used to fasten the cover-glass and seal the slide up. The other cause was the dampness often shewn after every pre- aution had been taken to have both object and cell thoroughly dry efore applying the cover-glass.

After trying every receipt I could find, I determined to try an dea of my own, and which, after many months' use, has answered he purpose remarkably well. No doubt others have found the same difficulties, so I am tempted to give my experience.

I found a remedy for running in; it was invariably with a cement that caused the dampness, and *vice versa*, so I determined to bring wax to my aid. My process is to get a spirit lamp and place it under a dish supported on a retort stand. Into the dish I pour white wax or bees wax, and melt it. It requires making very hot, and the lamp to be left continually under the dish. If the slide is to be opaque, I cut a piece of black paper to about the size of the cell to be made, and attach it to the slip. I then put it on the turn-table, and build up the cell with the hot wax. Of course it is allowed to overlap the paper background and the glass, and thus make a neat cell. It has the advantage of being built up to any thickness at once. There is also no untidiness of the paper not fitting the bottom of the ordinary vulcanite cell, or if it is placed on the undersides of it, being scratched off. Then again, if the background is put at the back of the glass slip, it is invariably bright instead of dull. When the slide is dry and ready for sealing up, all that is necessary is, place the cover on it and put it once more on the turn-table, when one turn, with the application of the wax brush, is sufficient to make it a permanent mount. It can then be finished with the usual varnishes.

I have described it for opaque dry mounts, but the process can be equally well used with transparent dry mounts. I also use the wax to help to fill up the sides of balsam cell mounts, between the closing cement and the finishing varnish.

In adopting this plan, the wax must be kept very hot, and the brush should be left in it when not in use.

I have never seen this process described, but since I found it out I have told many of my friends of it; they have all found it a great success.—JNO. E. FAWCETT.

LIVERPOOL MICROSCOPICAL SOCIETY.—We are writing with the Fourteenth Annual Report of this Society before us, and congratulate the President and Council upon the very interesting subjects brought before the Society during the past year. The catalogue of the contents of the Society's cabinet and of the books in the library show that the young student in Liverpool has many aids, denied to him residing in less favoured localities. Let us hope these advantages will be appreciated.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the usual monthly meeting held on March 19th, Captain Cunliffe in the chair, Mr. James Cash exhibited specimens of *Cinclidium stygium* from Malham Tarn, and read a paper on its history as a British Moss. The species strictly belongs to the flora of Northern Europe and the Arctic regions. It is recorded as growing at two stations in England and one in Scotland. It was first discovered by Hansworth, Greenwood, and Nowell, of Todmorden, during the summer of 1836.

Mr. Cash's paper was full of interest to the Lancashire botanist, including as it did the correspondence of Wilson, Hooker, and the Todmorden artizans on the subject of its discovery.

Mr. Foster exhibited a beautiful and robust form of the British fern *Polystichum angulare.*

THE MANCHESTER MICROSCOPICAL SOCIETY.—MOUNTING CLASS. —A very interesting and well attended meeting of the Mounting Section of this Society was held on Wednesday evening, Mar. 14th, Mr. R. L. Mestayer, C.E., in the chair.

The subjects dealt with were—mounting of the Wasp's head, *Vespa vulgaris* in pure balsam without pressure, by Mr. H. C. Chadwick, F.R.M.S., and the dissection of the Cockroach, *Blatta orientalis*, by Mr. H. P. Aylward.

The various organs of this common household visitant were laid bare by the demonstrator, and their structure explained, also hints as to the method of their preparation and mounting.

RAMBLES.—On Saturday afternoon, the 7th April, the first ramble of the season, in search of pond life (in connection with the Manchester Microscopical Society) took place. By the kind permission

of Robert Hibbert, Esq., who holds the right of fishing and shooting over the estate, given to Mr. Jas. Fleming, the leader of the party; the neighbourhood selected was Bramhall. This estate covers 2000 acres, and is thickly studded with ponds and water courses. The party on reaching Davenport numbered thirty-seven; the weather was splendid and favourable for the pursuit.

Angling in the ordinary way is different to the fishing for microscopic aquatic life. The followers of Isaak Walton require to use rod, line, reel, and bait, and usually eat what they catch. The scientific animalcule fishermen use rod, net, bottle and pocket lens, and the bait lies in the tact and knowledge they possess to discover the whereabouts, and to secure the many objects of their search. To both parties the tramp and the air of the open country are splendid appetisers and nerve invigorators. In both cases, practice makes perfect; but instead of eating their prey, the microscopic fishermen foster and watch, with eager eyes, the small things in nature, which, without the microscope, although so complete and wonderful in themselves, would be absolutely shut out of view.

It has been remarked that "size is no attribute of beauty," and Ruskin observes, "That which we foolishly call vastness is, rightly considered, not more wonderful, not more impressive than that which we insolently call littleness."

The most prolific ponds are those in which vegetation grows plentifully; about eight ponds of this character and the Lady brook were visited, and although the time was far too short, the result of the ramble was quite satisfactory.

In nice fruiting condition were gathered *Dicranum heteromallum*, *Brachythecium rutabulum*, *Phascum subulatum*, and *Fissidens bryoides*; also, *Hypnum cupressiforme*, *Hypnum elegans*, *Lophocolea bidentata*, and *Calypogeia trichomanis*.

The following Microfauna and Flora were found:—*Corethra plumicornis*, Ephemera larva, Larva of Dragon-fly, *Melicerta ringens*, *Hydatina senta*, *Hydra fusca*, *Cyclops quadricornis*, *Cypris tristriata*, *Daphnia pulex*, *Canthocamptus minutus*, The bloodworm, Nais, *Tubifex rivulorum*, *Coleps hirtus*, *Amœba princeps*, *Paramœcium aurelia*, *Stentor polymorphus*, *S. Barretti*, *S. niger*, *Epistylis grandis*, *Vaginicola valvata*, *Dileptus folium*, *Pandorina morum*. *Micrasterias rotata*, *Euglena viridis*, *Cosmarium tetrophthalmum*, *Closterium lunula*, *Sphærozozma vertebratum*, *Pediastrum granulatum*, *Tabellaria fenestrata*.

Withered Leaves.—Under this title a very interesting paper was read by Mr. J. W. Fisher before the members of the Ealing Microscopical and Natural History Club, and, since, it has been reprinted by the author for private circulation. It is illustrated with

seven figures and goes to show that if we only take one shrub or tree there is enough in that alone to occupy the serious attention of the microscopist for a lifetime, while a common weed from the roadside will be found scarcely less interesting. Mr. Fisher has put his matter in exceedingly good form.

BACK NUMBERS OF THIS JOURNAL.—We have succeeded in securing two complete sets of vol. I. The price, bound in cloth and sent post free, is fifteen shillings. Application for these should be made early to the Editor.

Only a few complete sets of vol. II. remain in stock.

OBJECTS MOUNTED "DRAUGHT" IN BALSAM.—At the last meeting of the Manchester Microscopical Society, Mr. E. Ward presented a communication upon the above subject: we expect to be able to print it in our next issue.

THE USE OF LANTERNS IN THE INVESTIGATION OF VOLVOX GLOBATOR.—Mr. Fleming, of Manchester, has we understand, exhibited some very interesting specimens of the above. We hope to give a more detailed description later on. They are best seen with a spot lens.

WORKING DISTANCE.—Upon going to press we have been asked to state the working distance of Zeiss homogeneous one-twelfth objective. It is a trifle more or equal to that of many dry "quarters" of 1/4" or 1/5".

OBJECTIVES OF ENGLISH AND FOREIGN MAKERS.—We have lately had a series of these objectives for trial. They were as follows:—

Designation.	Working Distance. Inch.	Real Focal Length.	Aperture.	Angle in Air.
One Inch	0.50	0.62	.24	28°
Half "	0.22	0.31	.32	38°
Quarter "	0.09	0.21	.58	70°
One-eighth "	0.05	0.14	.80	106°
One-tenth "	0.01	0.096	.92	133°

The one inch and the one-tenth we were much pleased with.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 30. *JUNE.* 1883.

ON GYRODACTYLUS ELEGANS.

By Herbert C. Chadwick, F.R.M.S.

GYRODACTYLUS ELEGANS is a trematode worm of parasitic habit. It was discovered in Germany by Nordmann, and afterwards described more or less fully by Creplin, Dujardin, Von Siebold, Diesing, Wagener, and Von Beneden.

The discovery of its existence in England was announced to the Linnean Society in the year 1860, by C. L. Bradley, Esq., F.L.S., who found it on the sticklebacks inhabiting the ponds on Hampstead Heath. In 1861, a translation of Wagener's paper appeared in the "Quarterly Journal of Microscopical Science," and in the following year, 1862, a short paper by Dr. Spencer Cobbold appeared in the same journal, in which he stated that he had found the Gyrodactylus on the fins of the sticklebacks inhabiting the Serpentine, associated with large numbers of Trichodinæ. I have recently found it on sticklebacks from a pond at Eccles, again associated with large numbers of Trichodinæ. In form, Gyrodactylus closely resembles the common sea-mouse, Fig. 43, being tongue-shaped, the dorsal surface being convex, and the ventral surface being flattened. The average length of the specimens observed by Wagener was $\frac{1}{100}$th of an inch, but the specimens which I have had under observation were larger, their average length being $\frac{1}{75}$th of an inch. The anterior extremity of the animal is divided by a median fissure or cleft into two cephalic lobes, Fig. 43 *d*; the cleft passing into a shallow groove on the ventral surface which leads to the mouth *m*. The posterior extremity expands to form the caudal disc, *c d*.

This organ is convex above and concave below, its broadest part being near its junction with the body. In the centre of its ventral aspect two hooks, *h*, *h*, closely resembling fish hooks, are placed back to back, the points being directed forwards and slightly downward, each point resting in the centre of a crescentic fold of

e integument. Each hook is provided with a lateral process, *p*, by which it articulates with an ossicle of crescentic form, *o*, hich is also provided with articulating processes, to which the ateral processes of the hooks are applied. This ossicle appears to me to be concerned in the movement of the hooks, but in what way I have not been able to discover. Between its extremities, which are sometimes truncated, sometimes pointed, an apparently fibrous band may sometimes be seen. The margin of the disc is produced into sixteen processes, each of which carries at its apex a hooklet, *h 2*. Each process, with its hooklet, is individually motile, the movement being effected by means of a linear tendinous appendage, *t*, which originates in the central portion of the disc, on its dorsal surface, and is inserted into the base of the hooklet. The hooklets are provided with two wings, to one of which the appendage is attached. Careful focussing of the microscope reveals a number of fine fibrils, which, in the central portion of the disc, are longitudinal, and are probably muscular. Attached to its finny host by the caudal disc, the animal may often be seen restlessly moving to and fro apparently in search of food. At one moment it is elongated to three or four times its ordinary length; at another it is so much contracted as to appear almost spherical. Locomotion is effected by means of the cephalic lobes, which possess considerable prehensile power, and the caudal disc. The body is first elongated considerably, and, the cephalic lobes being made to adhere to some fixed point, the caudal disc is brought up close behind, the body being thrown into the form of a loop. I am not aware that this parasite has been found upon any freshwater fish except the stickleback in this country, but it was found upon the gills of pike, carp, gudgeon, bream, Prussian carp, minnow, bleak, loach, and pond loach by one of the Continental observers. I have occasionally seen a stickleback make frantic efforts to rid itself of its tormentors, though I have known several to live for two or three weeks with a number of the worms on their fins and tails, without appearing to suffer any inconvenience.

I will now pass on to the consideration of the internal anatomy of the animal. The mouth, Figs. 43 and 44 *m*, when closed appears as a transverse slit, but when open it presents an oval or rounded aperture, having a wavy margin. The integument around it is radially striated. It opens almost vertically into a thin walled pyriform pharyngeal sac, Figs. 43 and 44 *p s*. This sac gives attachment to eight finger-like tentacular processes, Fig. 45 *t p*, which can be protruded through the open mouth, when they resemble an eight-rayed star, Fig. 46. The upper portion of the sac is divided into eight cell-like segments, Figs. 43 and 45 *c s*., in the centre of which a nuclear body, containing a dark nucleolus may be seen, the surrounding contents being finely granular. At the junction

of the sac with the short œsophagus, which appears to occur upon its posterior wall, I have frequently seen an organ which bears considerable resemblance to the mastax of the rotifera, Fig. 45 *m x*,

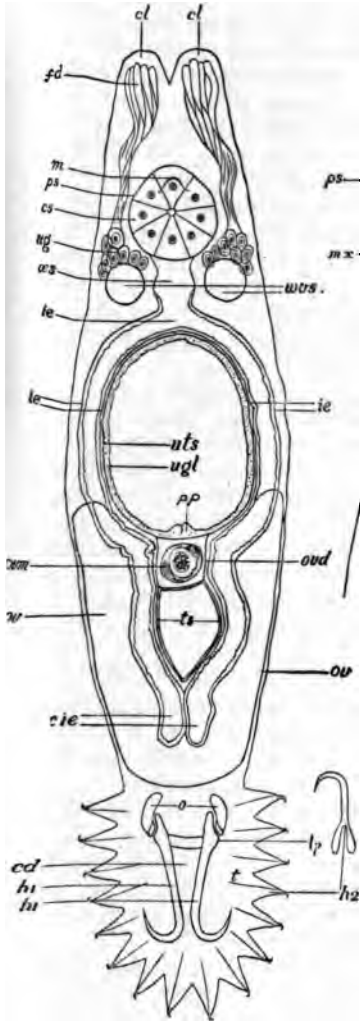


Fig. 43.

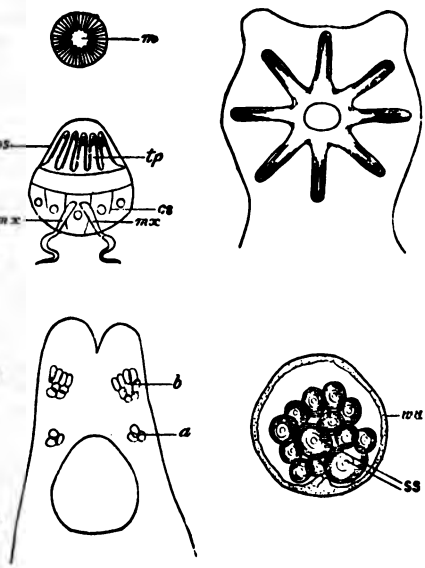
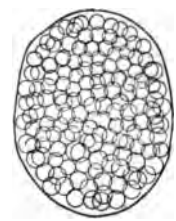


Fig. 44.
Fig. 45.
Fig. 47.
Fig. 50.



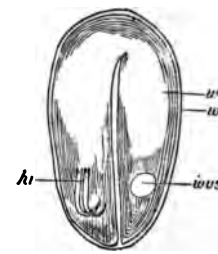


Fig. 46.
Fig. 49.
Fig. 51.

which appears to have been overlooked by previous observers. In the specimens which presented it most favourably for examinat[ion] it was composed of two knife-like blades working laterally, [and] coming in contact with each other by their points only. Outs[ide] the wall of the sac, the blades pass into handles in the form of [the] letter S. The blades, of which there are sometimes three [on] each side, appear to me to correspond with the mallei of the [nas]tax of the rotifera, the handle being comparable with the manub[ria]. The short œsophagus is somewhat dilated about the middle o[f its] length, Fig. 43 *œ s*, and passes into the intestine, *i e*, which d[ivi]ding into two branches immediately in front of the uterus, *u t s*, passes along its sides, just beneath the dorsal surface, and terminates cœcally, the ends of the two branches being applied to each other, *c i e*, and resting on the ovary. The intestine is composed of two layers, the outer one being thin and structureless, the inner being much thicker, and consisting of ill-defined and granular cells. On either side of the pharyngeal sac a group of cells, very variable in number and size, are situated, Fig. 43 *u g*. These are the so-called unicellular glands. Each cell possesses a nucleus and nucleolus, and from each a filamentous duct passes to the cephalic lobe of the same side, where it becomes much dilated, *f*.

The ducts are irregular in thickness, and are bound together in a spherical bundle. Wagener states that these glands secrete a yellowish oily fluid, which may sometimes be seen exuding from the ducts which open upon the cephalic lobes. Two much smaller groups of cells may often be seen on either side; one, containing three or four cells being situated close to the anterior border of the pharyngeal sac, Fig. 47 *a*, the other occurring at the base of the cephalic lobe, and containing from six to nine cells, *b*.

In contact with the unicellular glands, on either side of the œsophagus, there is a spherical contractile sac, containing a clear fluid, Fig. 43 *w v s*. In some specimens only one sac is to be seen, while others possess more than two, all of which may be situated on the same side of the body. The two sacs always contract at the same moment, frequently when the animal is moving actively, less often when it is at rest. Contraction is accompanied and apparently aided by a spasmodic contraction of the surrounding tissues, and results in complete obliteration of the cavity of the sacs. In a few seconds they become fully dilated again, and remain in this condition from one to three minutes.

Up to the present time I have not succeeded in tracing any connection between these sacs and any other structures, but they probably form part of a system of vessels described by Wagener, consisting of four principal trunks lying in pairs on either side of the body, near the ventral surface, and a number of minor branches, some of which are ciliated. These vessels contain a clear fluid.

Nerves have not as yet been discovered, and this species is remarkable for the absence of the four so-called eye spots which have been observed in every other species of the genus. The ovary is a large organ of somewhat crescentic form, occupying the posterior third of the length of the animal, Fig. 43 *o v*. Its blind end appears to be occupied by a mass of protoplasm, containing nuclei, but not divided into distinct cells. As the oviduct is approached distinct cells are found, consisting of a conspicuous nucleus, containing a nucleolus, and surrounded by a layer of protoplasm. These are the young ova. A mature ovum, such as may frequently be seen in the oviduct, Fig. 43 *o v m*, and Fig. 48, is generally more or less oval in form, and consists of finely granular protoplasm,

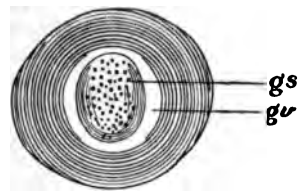


Fig. 48.

containing a large, clear nucleus, now called the germinal vesicle, and a darker granular nucleolus, the germinal spot.

In many Trematodes an accessory organ, known as the yolk gland, assists in the formation of the ovum, and I am inclined to think that such an organ exists in a rudimentary form in Gyrodactylus, but I am not yet in a position to speak positively on this point.

The oviduct is a short, wide tube, Fig. 43 *o v d*, opening into the uterus upon the posterior border of that organ. It is bounded laterally by the branches of the intestine, and is partially overlapped by the testis.

The uterus, Fig. 43 *u t s*, is rounded in form, and occupies nearly the whole of the middle third of the body. In the absence of an embryo, its cavity is filled with a clear fluid, and its membranous wall, *u t s*, is lined by a thick granular layer, *u g l*, which at the point of entrance of the oviduct forms a perforated papilla, *p p*, through which the ova escape into the uterine cavity.

The testis is a conical or heart-shaped body, Fig 43 *t s*, its base being applied to the upper wall of the oviduct. Its lateral borders, like the oviduct, are bounded by the branches of the intestine. According to Wagener, the *vas deferens* opens upon the upper wall of the oviduct. The spermatozoa are simple filaments. During the past four months I have had Gyrodactylus under observation almost daily, and have only seen two spermatozoa. One appeared

BACTERIACEÆ.

I. Cells not united into filaments, separating immediately after division, or in couples, free or united into colonies (zoogloea) by a gelatinous substance.

A. Cells dividing in one direction only.

α. Cells globular: *Micrococcus.*

β. Cells elliptical or shortly cylindrical: *Bacterium.*

B. Cells dividing regularly in three directions, and thus forming cubical families, having the form of packets strung crosswise, and consisting of 4, 8, 16, or more cells: *Sarcina.*

II. Cells united into cylindrical filaments.

A. Filaments straight, imperfectly segmented.

α. Filaments very fine and short, forming rods: *Bacillus.*

β. Filaments very fine and very long: *Leptothrix.*

γ. Filaments thick and long: *Beggiatoa.*

B. Filaments wavy or spiral.

α. Filaments short and stiff.

(*a*) Filaments slightly wavy, often forming woolly flocks: *Vibrio.*

(*b*) Filaments spiral, stiff, moving only forwards or backwards: *Spirillum.*

β. Filaments long, flexible, with rapid undulations, spiral through their whole length, and endowed with great mobility: *Spirochæte.*

Prof. v. Nägeli considers that any division of these organisms into species can be of no scientific value, since the same species may assume different forms in different media and conditions of life, and all known distinct forms are connected by intermediate links. Dr. L. Rabenhorst, in a recent work on the "*Kryptogamen Flora*" gives full descriptions and measurements of the species which he has recognized or which have been described by others. He makes an attempt at arranging them, in some of the genera, with regard to their qualities or functions, as colourless, pigment-forming, those producing fermentation, and those that are pathologically active. We learn that the round or oval cells of Micrococcus (Cohn) vary according to the species from .3 to 2 μ in length (1 $\mu = \frac{1}{25400}$ of an inch), and that a "doubtful species" may, in the act of division, attain the length of 6 or 7 μ. One pigment-forming species (*Micrococcus prodigiosus*, Cohn) is the cause of the so-called "blood-rain" on bread, the "host," &c. Another, the *M. ureæ* of Cohn, is the agent of ammoniacal fermentation; and another (*M. crepusculum*) appears with *Bacterium termo* in nearly all organic substances undergoing decay. The pathogenic species contain *M. vaccinæ*, the active element of vaccine lymph and small-pox; *M. diphtheriticus*, found on the mucous membrane in the subjects of diphtheria; and *M. septicus*, found in the blood and on wounds in cases of blood-

poisoning, pyæmia and septicæmia. In the genus Bacterium, of Cohn, we find the well-known *B. termo*, the most energetic of the saprophytes, found in many putrescent substances, and especially in macerations of muscular tissue, where they appear as oblong cells, about $1\frac{1}{2}$ to 2 μ long, with a flagellum at each end. Amongst the pigment-forming species of this genus are two, morphologically identical, which produce the so-called "yellow" and "blue" appearances of sour milk. The genus Sarcina is best known by *S. ventriculi*, found in the stomachs of man and other animals in health and disease; the individual cells sometimes attain a diameter of 4 μ. Other species are found in the bladder and kidney. The genus Bacillus, in its saprophytic character, is found plentifully in vegetable infusions. *B. subtilis* is the agent of butyric fermentation and the ripening of cheese, and is found abundantly in infusions of hay; cells usually as large as 6 μ long, a flagellum at each end. The well-known pathogenic species, *B. anthracis*, the cause of splenic fever (anthrax) in cattle and sheep, and of "wool-sorters' disease" (pustula maligna) in man, belongs to this genus; cells 4 μ long and very slender, without flagella. The more recently discovered *B. tuberculosis* (Koch) of pulmonary consumption has its place in this genus. The genus Leptothrix, some of the species of which are evidently phycochromaceous algæ, consists of colourless and motionless threads, and in one species these threads attain a length of 100 to 140 μ by 1 μ wide. Beggiatoa is found mostly in sulphur hot-springs, where it decomposes the sulphur compounds and liberates sulphuretted hydrogen; filaments actively oscillating and thicker than in Leptothrix. Some species are found in sea-water and marshes. It is doubtful whether Vibrio and Spirillum are distinct genera, since the discovery of flagella on the former, the latter only having previously been supposed to possess them; bent or spirally twisted filaments with a flagellum (in Spirillum) at each end; length and thickness variable; found as saprophytes in various infusions of organic substances, and in the putrefying water of bogs and ponds. Spirochæta is distinguished from Spirillum by the greater number and closeness of the spiral turns, and the long and slender threads. The species are saprophytic, like Spirillum; one is pathogenic and is found in the blood during the febrile stage only of intermittent fever, disappearing during the intervals of freedom.

Reproduction by spores has been observed in Bacterium, Bacillus, Spirillum and Spirochæta; and these genera and Micrococcus are sometimes found in zooglœa masses.

For a more detailed account of the various species into which Cohn and other authors have divided the genera, I would refer the reader to Hardwicke's "Science Gossip" for 1882-3, where he will find "Notes on the Schizomycetes," communicated by Mr. W.

B. Grove, B.A., Hon. Sec., Birmingham Nat. Hist. and Micros Soc., and accompanied by typical illustrations. An excellen systematic account of the family will be found in Dr. A. Magnin' "Bacteria," translated by Dr. Sternberg, (Boston, U. S. A.), illus trated by photo-micrographs.

Since Pasteur's discovery of the "attenuated virus" of anthrax it has been an interesting problem whether, and under what con ditions, an innocuous saprophyte can become a noxious parasite whether, for instance, the active and harmless *Bacillus subtilis*, o hay infusions, may be converted, by change of "soil," into th motionless and deadly *B. anthracis* of splenic fever; and if so whether the converse proposition may not also be true, viz.: tha the noxious parasite may become changed into the innocuou saprophyte. In other words, is the parasite a "sport" from th saprophyte? Prof. von Nägeli and his pupil, Dr. Hans Buchner have undertaken this investigation, and believe that they have con firmed the truth of this theory. The latter states that he has no only converted the Bacillus of anthrax into another, morpholog cally identical with the Bacillus of hay infusion, but that he ha also transformed the latter into the dangerous pathogenic parasit of anthrax. Dr. Klein, who has also carried out a series of simila investigations, does not regard this as proved. The importance c this question can scarcely be over-estimated, because if the pathc genic species are sports from the harmless ones, a knowledge of th conditions of life upon which such a change is dependent may b the means of preventing some virulent contagious diseases. Th consideration of this question I must reserve for another occasion

(To be continued.)

MOUNTING OBJECTS IN PHOSPHORUS.

IN a paper read before the Royal Microscopical Society on th 11th of January of last year, Mr. J. W. Stephenson gave th details of this method of mounting, and stated that the slides prepared "nine years ago, and exhibited on the 4th June, 1873, still remain unchanged.

There are four points of importance:—

1. The object must be absolutely dry.
2. The phosphorus must be introduced with the least possibl exposure to the air.
3. The solution of phosphorus must be clean and bright, and
4. The operator should have both water and oil (olive) at hanc

cannot be kept alive for more than five or six days, and this fact prevents continuous observation for any lengthened time; hence it happens these specks often pass away unobserved, and their actual nature, for the most part, is undiscovered and unexplained. Early in March the writer collected a quantity of Volvox, and at once noticed the white specks, usually of a round or oval shape; being fortunate enough in keeping it alive for eleven days, he was enabled to watch the whole hatching process.

Ehrenberg divides the family of the Notommata into 23 species; two of them are parasitic,—*N. petromyzon* and *N. parasitica*. He remarks that "the latter class lives in the globes of the *Volvox globator*, where it deposits its eggs, which are there hatched; and when of a proper age, the creature eats its way through the hollow sphere."

From this quotation it might be inferred that the presence of eggs in Volvox is not an accidental occurrence, but rather a natural and usual circumstance.

These creatures are also found in other Algæ, *viz.*, the *Vaucheria clavata*, as well as in the cells of the Bog Moss. They have a roaming disposition, and are of no settled habitat; their fecundity is enormous, and their power to endure the widest extremes of temperature remarkable.

More frequently, the eggs are found in decaying Volvox, having rents and openings all round; and this condition of the plant favours the view that the eggs have been accidentally washed in; but the writer has seen them in perfectly sound and healthy Volvox, without any breach, so far as could be seen, in the peripheral envelope, and, indeed, he has seen them in the interior of young Volvox whilst yet within the parent sphere.

On the fifth day of observation, the stirring of life in the egg was noticed; and in two or three days more the whole hatching process was completed.

The Rotifer, after living on whatever nutriment there was in the egg, commenced crawling about in worm-like fashion, on the inner surface of the globe; the Volvox, all the time, continuing the usual spinning and rolling motion. Whether the activity and freedom of of the plant is essential to the life of the Rotifer or not, it will be noticed that when the Volvox dies—which is usually very sudden —all observation is terminated, for the house and its tenants are together dissolved and disappear.

On compressing a newly hatched Rotifer chlorophyll grains are found in the stomach, and this may indicate the instinct of the parent in placing her eggs where congenial food was at hand; but *how* the creature "deposits its eggs within the globes of Volvox globator" is a question which requires answering, and is worthy of the attention of all microscopic naturalists. The hatching is best witnessed with a dark ground illumination.

Dr. Morris' method.—First gently warm the slide, centre it on the turntable, warm the cover glass, and place it on the slide, wash the pipette with a little carbon bisulphide, take up a small quantity of the solution of phosphorus, and allow it to run under the cover just to float it. Take a small brush, load it with the melted cement, and touch the edge of the cover glass in four places, gently revolve the turntable, keeping the brush close to the cover until the cement ring is complete, then absorb the remainder of the phosphorus solution with strips of blotting paper, putting the paper in water so that it may not inflame. After a day's rest the slides may be examined, and, if perfect, finished with a ring of sealing wax or shellac.

Precautions to be taken.—Both phosphorus and bisulphide of carbon are extremely inflammable substances, and require to be used with the utmost caution. Burns resulting from accidents with phosphorus are usually very severe. All paper and textile substances brought into contact with the solution of phosphorus in bisulphide of carbon should be put into water at once to be burned or cleansed at leisure. If spilled on the hands it should be removed *instantly* with olive oil. The operator can hardly be too careful in handling the solution, and even after the slide is mounted there is danger. Mr. Frank Crisp, at the meeting at which Dr. Morris described his process, said, "It must be borne in mind that the danger incidental to the use of phosphorus was not confined to the process of mounting. A case recently occurred, in which an object glass brought down too hard, broke the cover glass, and the observer having wiped off the exuding phosphorus with his handkerchief put it into his pocket, and set himself on fire.

PENETRATION IN OBJECTIVES.

THERE are yet many microscopists who consider "the battle of the glasses" not fought out, and who still look upon the various statements made from time to time upon the "penetration" of objectives as so many theoretical speculations not proved by practice.

It is to these we now address ourselves, and knowing that mathematical problems are not cared for generally by the majority of microscopists, put the matter in a practical form in order to win the sympathies of those with whom hypotheses, of whatever kind, are subordinated to what can be seen "over the tube." Professor Abbe has demonstrated, in a very clear manner, how penetration

in the microscope is obtained, but the subject has never been popular, nor will it be so until an effort is made to show, in absolute measure, how much penetration can be obtained from any given objective.

To any one who has mastered Professor Abbe's elaborate papers on this subject an explanation will be unnecessary, but to many it may be an aid, by freeing the matter from the greater portion of its technicalties, and it is hoped will also act as an incentive to the study of "penetration" and "aperture" a little deeper than is usually the case.

In making microscopical measurements the most convenient unit to adopt is the *micra*. This unit is the thousandth part of a millimetre, or the $\frac{1}{25400}$ part of an English inch; but if a proper appreciation is obtained of the magnitude of the *micra* it is unnecessary, nay, injurious, to hamper one's mind with the knowledge that it is a fraction of either of the above linear standards.

Let the student of microscopy consider the micra on its own merits, as a minute standard of measurement, the magnitude of which may be appreciated by the knowledge that the small diameter of some species of bacteria is equal to one micra, the spores of the mould fungus *Penicillium glaucum* 3·0 micras, the long diameter of tous-les-mois starch about 96 micras, while the diameter of many of the Foraminifera reach from 300 to 800 micras. For brevity the word micra is usually written μ.

Now, Professor Abbe has told us that the penetration of the microscope depends principally upon three factors:—

1. The accommodation of the eye.
2. The focal depth of the lens itself.
3. The medium in which the object is immersed.

So that a practical turn may be given to the subject by elaborating the figures given by Professor Abbe, on page 680, vol. i., series ii., of the *Journal of the Royal Microscopical Society*. There is little doubt that such a method as this will help the student to understand the true value of penetration in by far the best manner; and may possibly give a hint to the photomicrographer as to the lenses he must employ when it is desired to photograph solid forms. It will be readily understood that when it is desired to photograph pyramidal forms the penetration must necessarily enable a well defined picture to be taken from apex to base at one focussing; but when the object is of spherical nature the penetration need only approximate to little more than half the diameter, unless it is wishful to show the uppermost layer of the preparation, as well as the slide itself, simultaneously.

I. The "accommodation depth" may vary a little according to the sensitiveness of the observer's eye, and other physiological conditions; but with the same observer the only serious quantity

we have to consider is the amplification, and we shall find that a four-inch lens magnifying 10 diameters, with the A ocular, yields us a penetrating power from the eye alone of 2,080 micras; a one-twentieth of an inch gives only a penetration of one-fifth of a micra.

II. The "focal depth" of the objective depends upon the aperture employed for producing the various amplifications. A four-inch of 16° air-angle would have a focal depth of 262 micras, while an inch and-a-half objective, of the same air-angle, yielding an amplification of 30 diameters, could only penetrate through 86 micras.

A direct comparison of several objectives of different apertures and varying amplifications, may with advantage be introduced here, and the table goes to show that what is seen down the tube of the microscope results from the combined effects of the eye and the objective, but when a picture is thrown upon a sensitive plate it is evident that the first quantity is nearly eliminated, and the only penetration attainable is that which the lens itself possesses. The objectives are each and all supposed to be used with the A ocular.

TABLE I.

Inch.	Air Angle.	Aperture.	Penetrating Power $\frac{1}{a}$	Focal Depth in Micras.	Accommodation Depth of Eye in Micras.	Total Depth of Vision in Air. Micras.
4	8°	.07	14.30	522	2080	2602
4	16°	.14	7.19	262	2080	2342
1½	16°	.14	7.19	86	230	316
1½	20°	.17	5.75	69	230	299
1½	24°	.21	4.81	57	230	287
½	40°	.34	2.92	10.6	20	30.6
½	70°	.57	1.74	6.3	20	26.3
½	110°	.82	1.22	4.4	20	24.4
⅙	74°	.60	1.66	1.99	2.3	4.29
⅙	100°	.76	1.31	1.57	2.3	3.87
⅙	... ...	1.20	.83	.99	2.3	3.29
$\frac{1}{12}$	110°	.83	1.20	.72	.58	1.30
$\frac{1}{12}$	144°	.97	1.02	.61	.58	1.19
$\frac{1}{12}$	... ...	1.10	.91	.54	.58	1.12
$\frac{1}{20}$	160°	.98	1.02	.37	.21	.58
$\frac{1}{20}$	... ...	1.10	.91	.33	.21	.54

From the foregoing table it will be seen that large objects cannot possibly be penetrated even with objectives of low angle and medium power. The seeds of the *Betula alba* measure 1,100 micras across them, and require therefore 550 micras of penetration

to see the whole of one of them under one focussing. This amount cannot be obtained from a 1½ inch objective of 16° air-angle, even allowing the 230 micras, which the accommodation of the eye affords, and if we wish to photograph such an object as the above, the four inch of 8° air-angle will not be found possessing sufficient focal depth.

The Foraminifer *Orbulina universa*, a beautiful spherical body with fine surface markings, is now before us. It possesses a diameter of 600 micras, and consequently 300 micras of penetration are necessary to see the whole under one focussing. The 1½ objective and A ocular magnifying together 30 diameters will just suit this, provided it does not possess an angle of over 20° in air, but if we wish to photograph this spherical body a much lower power than the 1½ inch must be employed, as the focal depth of this objective is not higher than 86 micras. *Orbulina universa* affords us good proof of the accuracy of Professor Abbe's figures. Under the 1½ inch objective of 16° and the A ocular the spheres are splendidly seen, and the same may be said of the 2 inch of 16° and B ocular, but when the picture is thrown upon a ground glass screen the want of penetration is soon apparent, for it is only when the amplification of the picture has been reduced to rather less than 10 diameters that a satisfactory result is obtained.

Similar illustrations may be offered of the higher power objectives, the difficulty of photographing depth in polycistina is shown by the photographs A and D in our September number of last year. The larger species of Polycistina require a depth of 75 micras to show them distinctly, whereas a half-inch objective of 40° in air when used with the A ocular to produce 100 diameters of amplification possesses but 10·6 micras.

A one-sixth objective, magnifying 300 diameters, loses exactly one μ in depth between 74° air-angle and 1·2 Numerical aperture, so that while the spores of *Penicillium glaucum* (diameter of spores 3 μ) could be photographed with the former, it would be impossible to obtain perfect sharpness with the latter.

The figures in Table I. for the one-twelfth and one-twentieth objectives are equally confirmed by the results obtained in practice. The short diameter of *Bacterium termo* may be taken as ·8 μ requiring a penetration of ·4 μ to yield a clear picture, and this is obtainable by using a homogeneous one-twelfth of 1·10 N. A. to produce an amplification of 600 diameters. A one-twentieth objective, magnifying 1,000 diameters, although producing a fairly sharp picture to the observer's eye, cannot produce an equally sharp image on a prepared plate, as the focal depth of such an objective will only approximate to ·37 μ, and this statement is borne out by the photographs published by Dr. Sternberg in his translation of Magnin's treatise on the Bacteria, wherein those

pictures taken with a Beck's one-fifth are much clearer though smaller than the plate taken with Zeiss' one-eighteenth. There is more detail in the latter, and here comes in the value of amplification and aperture.

III. We have not yet noticed the third element which goes to make up penetration in the microscope. The depth of vision increases in direct proportion with the refractive index of the mounting medium. Thus if a combination of lenses possessed a penetrating power of 100 micras when used over an object mounted dry that depth would be increased to 133 μ when mounted in glycerine, and to 152 μ in balsam, 168 μ if in iodide of potassium and mercury, and to 210 μ when it is mounted in phosphorus. The great gain in stereoscopic effect, on objects mounted in a medium of high refractive index, has led Mr. E. Ward, of Manchester, to mount opaque objects in balsam, with extremely good results.

FISH CULTURE AT WALKER WOOD RESERVOIR.

By R. Stanley, Esq., J.P.

I DARE say many of you think it is scarcely necessary to take this trouble, as the fish would naturally breed themselves. So they did before these reservoirs were made, when the stream was in its normal condition; but in making these reservoirs the natural breeding places were covered with deep water in which trout spawn would be destroyed when deposited by the fish.

Trout spawn, to act successfully, must be placed on a gravel bottom, in pure spring water, from one to three inches in depth; but even then a very few of the eggs hatch out, as birds, fish, and many kinds of larvæ eat great numbers of them, leaving very few to grow to mature fish. If therefore we did not resort to artificial breeding scarcely any fish would be found in the reservoirs.

In artificial breeding, however, we can increase the number to any extent, as, on the average, trout or any of the salmon tribe will yield 1,000 eggs to each pound weight of the parent fish, of which we can hatch out over 90 per cent.

Very pure water is only required for hatching purposes, as mature fish will live and thrive in comparatively impure water, provided that their natural food is present; so that there are a great number of ponds, brooks, and canals that would maintain fish, but which are not adapted for breeding fish.

in case of accidents, as burns from phosphorus are no slight matters.

Preparation of the phosphorus solution.—The solution is made in a 2 drachm bottle without any contraction for the neck. A filter of bibulous paper is folded round a cylinder of wood so that it fits tightly into the bottle, to the bottom of which it is forced, and the wooden cylinder withdrawn. The filter is now moistened with a few drops of bisulphide of carbon, any excess employed being emptied out. A piece of stick phosphorus, about $\frac{1}{4}$ inch in length, is then dropped into the filter, and the bottle corked. In about half an hour the phosphorus will be entirely dissolved, and by taking hold of the edges of the filter with a pair of forceps, and very slowly drawing it upwards, the brilliant highly refracting fluid is filtered into the bottle. The filter must now be plunged instantly into water to prevent its spontaneous inflammation.

Preparation of the cement.—Soak some of the best white glue in water for 12 hours. At the expiration of that time pour off the excess of water, and melt up the softened mass at a gentle heat, add a small quantity of honey, and evaporate in a gallipot surrounded with boiling water until when cold it forms a rather stiff jelly.

At the June meeting of the Royal Microscopical Society Dr. Morris, of Sydney, gave the following formula for a cement to be used in this process:—Take one ounce of good isinglass, place it in a saucer, and add a few drops of water from time to time until the isinglass is moistened, but not pappy. Place two ounces of glacial acetic acid in a gallipot, and bring to the boiling point, add the isinglass by degrees until the whole is dissolved, keeping the mixture constantly stirred. Boil until a spot placed upon a slip of glass becomes well solidified, when cold. This cement must always be warmed in hot water before applying it.

Method of mounting (Stephenson's).—Let us suppose the objects to be diatoms adhering to the thin glass cover. Make a ring of the cement upon the slide, somewhat smaller than the cover, and when nearly dry, this latter is placed upon it, but raised on one side by a thin bristle. Some of the liquid phosphorus is then to be taken out of the bottle with a fine pointed pipette, and forced between the cover and the slide. The cover is gently pressed down, and the mount closed by passing some of the warm preparation of glue round it. When this has set securely, the superfluous phosphorous may be removed by a piece of blotting paper moistened with bisulphide of carbon, special care being taken not to touch the paper with the fingers.

The slides may now be put away for a day or two when they can be finished by giving two or three coats of gold size, and a final coat of shellac.

to the supply, at a nominal cost, if breeding was patronised by the Government, or by some association formed for that purpose.

The Fisheries' Exhibition, under the patronage of the Queen, and of which the Prince of Wales is chairman, is now opened in London, and those who visit it will be much pleased and interested with what will be exhibited. I have no doubt that it will be the means of bringing the matter prominently before the public, and some steps may be taken to make the exhibition of permament benefit to the country.

THE PREPARATION OF DIATOMS FROM THE LONDON CLAY.

IN April, 1881, Messrs. Shrubsole and Kitton presented a paper to the Royal Microscopical Society upon the "Diatoms of the London Clay," obtained, in the first instance, from a well at Sheerness, and afterwards near Oldham Gap, at Upnor, Lewisham, Bishop's Stortford, Prittlewell, near Southend, and other places.

Dr. Bossey, of Redhill, seems to have furnished much assistance in these discoveries. He was the first to observe that the diatoms existed in two states: the one heavy and solid, consisting wholly of mineralized forms appearing in the clay as solid, shining, metallic spots; the other not so completely mineralized, bearing examination with high powers by transmitted light. As an incentive to further work in this direction we reproduce Dr. Bossey's instructions for the preparation of these transparent forms :—

"Dry the clay, and put it into a tall glass jar half full of water. Shake it gently, let it stand three or four minutes, and then pour off the thin portion. Repeat this process as long as a turbid milky fluid can be poured off. In thus washing away the lighter matter always leave an inch or two of water above the sediment. When the sediment has been well washed pour some fresh water into the jar, and very quickly pour off the turbid fluid, leaving only coarse sand, lumps of clay, &c. Repeat this process three or four times, and collect all that has been washed over, and set it aside till everything has subsided from it. Pour off nearly all the water from this sediment (which contains the diatoms), and put the sediment with a little water into a watch glass. Blow air through a pipette into the watch glass, so as to set the whole of the contents whirling round the watch glass. While the fluid is still in motion put the point of the pipette into the cone of floating matter, which will be found in the centre of the glass, and draw up some

of the water with such particles as will rise with it. Blow this out of the pipette on to a slide, or into another watch glass, and dry off the water. The partially transparent diatoms will be found chiefly on the surface.

"These light forms are not nearly so abundant as the more thoroughly mineralized ones, and are not always to be found in clay containing the others."

This subject will be found of extreme interest to the chemist, as it is left for him to determine whether the pyrites has been deposited upon the siliceous frustule, or, what is very improbable from a chemical point of view, replaced it. Mr. Kitton thinks the latter. He writes:—

"This metallic appearance is undoubtedly caused either by the deposition of iron pyrites (ferric bisulphide) upon the siliceous skeleton, or it has replaced atom by atom the original silica of the diatom frustule. I was at first inclined to the former supposition, and which the appearance of the valve seemed to confirm; the lustre-less somewhat granular character of the exterior, and the smooth polished interior surfaces forcibly reminding one of the electro-galvanic deposition of metals. Acting on this supposition, I thought it might be possible to divest the silica of its metallic coating, and thus be able to ascertain the species with greater certainty. To effect this, I submitted some of the material to the action of boiling nitric acid. This very effectually removed the pyrites, and was equally effectual in the destruction of the diatom. Supposing that this treatment was too violent, I placed some valves and frustules in an excavated slide with some very dilute acid, and placed over them a thin cover glass, and watched the action under a $\frac{2}{3}$ objective. In the course of a short time I saw the valves become more and more transparent, and at last disappear, leaving only a faint yellow stain in the acidulated water. I may here observe that I could detect no symptom of effervescence upon the surface or around the edges of the valves or frustules. This experiment, I think, fully justifies the supposition that the silica has been replaced by, rather than that a deposit of pyrites had taken place."

The diatom frustule is an exceedingly thin and fragile body, and it may be that a coating of pyrites has been deposited upon it by the reducing action of the organic contents upon a sulphate of iron. The coating may, perhaps, have adhered so firmly as to break up the valves into innumerable fragments when digested with nitric acid. It is evidently a question for the chemist, and one which is worthy of solution.

OUR BOOK SHELF.

MICROPHOTOGRAPHY. Malley. London: Lewis, 136, Gower Street. 1883.

Under this title the author publishes a treatise of instruction in photo-micrography. It should be known by this time that there exists two kinds of photography with the microscope—the one in which large objects are reduced to microscopic proportions, such as the exquisite productions of Mr. J. B. Dancer, the other wherein small objects are photographed upon an extremely magnified scale; the former is called micro-photography, the latter photo-micrography, and it is well there should be this distinction.

The first two chapters, of which one is introductory, though of an elementary nature, may be read with profit even by advanced photographers, as the matter is woven up with many hints showing the practical character of the author's experience. With the first two paragraphs on page 25 we cannot agree. The author instructs his reader to "avoid purchasing instruments adorned with mechanical arrangements for performing the various movements." Our advice is exactly the reverse of this; in no operation have we found the mechanical stage so useful as with photo-micrography, and we cannot by any means concur with the statement that "the various additions generally made to the first-class instruments of the present day are an insult to the skilled microscopist, and a means of perpetuating clumsy manipulations." After all, if a microscope were built from the author's specifications on p. 25, *et seq.*, and were the operator provided with all the apparatus mentioned, he would by no means find himself possessed of a second-class instrument, nor be short of appliances.

The mounting and preparation of objects intended for photo-micrography will be found a very useful chapter, and special attention may be called to the last paragraph on p. 72.

The chapter on the arrangement of the apparatus is the most valuable in the whole work, and will alone repay the purchaser for his outlay; the management of the light, on page 113, specially deserves attention.

We hope there is a sufficient demand for a work of this kind to call forth a new edition at an early date, so that the author may have an opportunity of correcting the numerous errata which are to be found in the volume before us. We hope also that he will endeavour to provide his readers with better illustrations of the photo-micrographic art in a future edition. The frontispiece hardly gives an idea of the manipulative skill which the author must have acquired during his ten years' experience, and those of us who are

acquainted with the splendid photographs of Mr. G. J. Johnson of the Manchester Microscopical Society, Mr. J. H. Jennings of Nottingham, and those of Mr. W. Shipperbottom of the Bolton Microscopical Society, will hardly be tempted to call the present frontispiece satisfactory.

THE METHODS OF MICROSCOPICAL RESEARCH. By JOHN ERNEST ADY.

Under this title a small volume is announced, to appear in weekly or fortnightly numbers, commencing on the 16th June, 1883, approximately. It is to be sold to subscribers at the small cost of 4s., and has been written as an introduction to the "*Studies in Microscopical Science.*"

The major portion of this work must necessarily be a compilation, but in addition it will contain a fair proportion of information arrived at through experiment. We cannot do better than illustrate this with a few examples.

The first chapter includes a brief description of instruments, to be fully illustrated with engravings and references given to other works where detailed descriptions of instruments may be found.

The second chapter will treat of reagents and their uses, and it is intended that this shall form the most important portion of the work. Each reagent will be fully considered; its source, physical properties, chemical constitution, and manufacture will be given where possible, and its specific action on various tissues exemplified. In the "Studies in Microscopical Science" this will be supplemented by laboratory notes as follows:—"If a thin section of the thymus gland is stained and mounted in Canada balsam, it is rendered most suitable for the examination of its cellular elements such as the lymphoid cells, the concentric corpuscles of Hassall, etc., but the broader distinction of its follicles into cortex and medulla, and their relative proportions, is almost obliterated through the diaphanic action of the mounting medium employed. To attain such a result the best reagent known is pure glycerine." So, through the entire series of organs and tissues, their characteristics will be detailed, and the reader find a ready guide to their elucidation in these preliminary pages.

The third chapter will be thoroughly practical, in noting the trivial as well as the important items to be observed in section cutting, staining, etc. The entire substance of these pages will be based on experiment.

Other chapters deal with microscopical art, and although the directions given may be found in other works, they will be so arranged as to enable the student, through examples, to work progressively and successfully. One novel feature in these chapters is the illustrations of lithographic drawing which they will embrace.

Altogether, the work will supply a demand which has long been felt by workers with the microscope, to possess a handy book based upon verified results. Messrs. Bailliere, Tindall, and Cox, of 20, King William Street, Strand, London, W.C., are the publishers.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

TO OUR SUBSCRIBERS.—We had expected that the 1882 volume would have paid its expenses, but on settling all accounts for that year we are sorry to find a considerable sum due to the editor. On further examination it is found that the loss is due principally to the enlargement of the journal, and to the extra postage occasioned thereby. On analysing our sales it is seen that since the increased number of pages was given, only 15 extra copies have been sold, and, therefore, we are compelled to reduce the weight of the journal, so that it will be carried for a halfpenny. This we hope to do without injuring its practical character, and we shall be exceedingly glad to restore the four pages so soon as our sales list shows that this may be done without pecuniary loss to ourselves.

We have been surprised at the very large number of microscopists unacquainted with the existence of THE MICROSCOPICAL NEWS, and we ask our readers earnestly not to hide their copy under the bushel, but to bring it to the notice of their friends. Such a proceeding would enable the journal to be better illustrated than it is, producing a benefit alike to subscribers and editor.

OUR FREE LIST.—We are reluctantly compelled to close our free list. It is our earnest desire that the journal shall be made to pay its way, and, therefore, economy must be practised in every department. We hope the recipients of gratuitous copies will look at the matter from a purely business point of view.

THE FISHERIES EXHIBITION.—Mr. Thomas Bolton, of Birmingham, has arranged to exhibit living organisms under the microscope at the International Fisheries Exhibition, which was opened on the 12th of May, at South Kensington. The exhibits, in addition to the six microscopes in use for showing living objects, include various small aquaria adapted for keeping microscopical organisms, containing a variety of fresh water and marine life, appliances for the collection of specimens, and for their examination under the microscope; microscopes suitable for students in Natural History,

Some years ago I induced the Waterworks Committee to allow the introduction of breeding for these reservoirs in order to increase the number of fish, not only to find sport for the people of the district who delight in angling, and who sometimes go a great distance to enjoy a day's fishing, but also to improve the quality of the water by keeping down the excess of insect life that was becoming troublesome and unpleasant by entering the supply pipes, and making its appearance in the water used for drinking purposes.

I went to Westmoreland and brought a quantity of red or Windermere char, and placed them in the reservoir below the keeper's house. These fish were supposed to be peculiar to Windermere, but they have thriven very well here, and gentlemen who have caught them say that they are now finer than those of Windermere. Of course they will not succeed in every water; some judgment is required as to the special kinds of the salmon tribe that will succeed in any particular water; for though they all belong to one family they differ very much in constitution and the kinds of food they require, just as the sheep on these hills would become diseased in the summer on rich pasture land; or, if Leicester or Southdowns were brought up here to stand the winter.

At my request, the committee have agreed to order for their extensive reservoir at Greenfield a quantity of Loch Leven trout, which grow to a large size in a very short time; also Windermere char and Welsh char, with a few American trout. For the Knott Hill reservoir, in which there are a large number of cray fish, a quantity of Gilleroo trout have been ordered. This trout is peculiar to some of the Irish lakes, and its natural food consists of cray fish, so that we may expect the Gilleroo to thrive there. They have also ordered for the same reservoir both kinds of char.

Altogether the committee have bought 9,000 young fish, so that in a few years, when they have come to maturity, the anglers in the neighbourhood may expect to have some good sport. With respect to breeding fish the matter is very simple when understood. All that is wanted is a never-failing supply of pure water, and by the construction of a small tank a few stock fish may be kept, and a supply of young fry hatched every season. All the ponds and streams in the neighbourhood may be kept supplied with fish at a trifling expense. The French government, over twenty years ago, erected a fish breeding establishment in Alsace and Lorraine, and were very successful in restocking the French waters with fish. In the late Franco-German war these provinces became part of Germany, and the Germans still carry on the system of fish culture. A supply can be there obtained, at a nominal cost, of any kind of fish it is worth while to cultivate.

In Roman Catholic countries more importance is attached to the supply of fish than with us; but a large addition could be made

trouble to the microscopist when mounting in this medium. The process is a ready and satisfactory one for objects of this character; a mount of *Fissidens bryoides* being washed, boiled, and the slide cleaned, ringed with white cement, and successfully completed in a little over half an hour.

In the senior division Mr. Miles mounted in balsam sections of lung showing tuberculosis, and injected sections of the cortical layers of kidney with the malpighian bodies and urinary tubules or ducts. He also mounted slides of gamboge as fluid mounts, interesting as illustrating molecular motion, or what is known to microscopists as the Brownian movement, from Dr. Robert Brown having, in 1827, clearly demonstrated that this movement is common to all bodies if they are sufficiently minute. Gamboge, Indian Ink, and Carmine, from their density approaching that of water, exhibit the phenomena very distinctly under a power of 300 diameters.

The minute particles are seen to move irregularly to the right and left, backwards and forwards, as if repelled by each other. This movement was seen to be still active, after a lapse of sixteen years, in a slide of gamboge, mounted by Mr. R. L. Mestayer, which he exhibited at a previous meeting of the section, clearly showing that evaporation is in no way connected with it.

EXCURSION.—This Society had its second excursion this season on Saturday, April 21, 1883, when about thirty members paid a visit to Stalybrushes under the leadership of Mr. Wm. Stanley, F.R.M.S. This district, although a very fine one for its mountain scenery and bracing character of its atmosphere, is rather late for flowering plants, and does not offer many advantages for the searcher after pond-life; only a few specimens of any interest being collected: notably, the Water Blinks, *Montia fontana;* the common Cotton Grass, *Eriophorum angustifolium;* and the Water Ranunculus, *R. Lenomandi;* of pond life, *Batrachospermum moniliforme; Hydra viridis;* larvæ of the Water Beetle, *Dytiscus marginalis;* and the Fairy Shrimp; but in spite of the great alterations which have taken place by the formation of four large reservoirs for the supply of water to the district, it is exceedingly interesting to the muscologist, and two or three good finds were made. Mosses—*Dicranella squarrosa, Philonotis fontana, Fontinalis squamosa,* and *Hylocomium flagellare.* Hepatics—*Cephalozia fluitans* (obtusiloba), *Jungermannia sphærocarpa, Nardia scalaris,* and in nice fruit, *Scapania undulata* and *Cephalozia bicuspidata.*

The party was accompanied by Mr. R. Stanley, J.P., late chairman of the Waterworks Committee, who, on reaching the key-house at the head of Walker Wood reservoir, explained the process of fish culture carried on by him during the last few years, and distributed to the members present, several of the fertilized ova for future observation.

of the water with such particles as will rise with it. Blow this out of the pipette on to a slide, or into another watch glass, and dry off the water. The partially transparent diatoms will be found chiefly on the surface.

"These light forms are not nearly so abundant as the more thoroughly mineralized ones, and are not always to be found in clay containing the others."

This subject will be found of extreme interest to the chemist, as it is left for him to determine whether the pyrites has been deposited upon the siliceous frustule, or, what is very improbable from a chemical point of view, replaced it. Mr. Kitton thinks the latter. He writes:—

"This metallic appearance is undoubtedly caused either by the deposition of iron pyrites (ferric bisulphide) upon the siliceous skeleton, or it has replaced atom by atom the original silica of the diatom frustule. I was at first inclined to the former supposition, and which the appearance of the valve seemed to confirm; the lustre-less somewhat granular character of the exterior, and the smooth polished interior surfaces forcibly reminding one of the electro-galvanic deposition of metals. Acting on this supposition, I thought it might be possible to divest the silica of its metallic coating, and thus be able to ascertain the species with greater certainty. To effect this, I submitted some of the material to the action of boiling nitric acid. This very effectually removed the pyrites, and was equally effectual in the destruction of the diatom. Supposing that this treatment was too violent, I placed some valves and frustules in an excavated slide with some very dilute acid, and placed over them a thin cover glass, and watched the action under a $\frac{2}{3}$ objective. In the course of a short time I saw the valves become more and more transparent, and at last disappear, leaving only a faint yellow stain in the acidulated water. I may here observe that I could detect no symptom of effervescence upon the surface or around the edges of the valves or frustules. This experiment, I think, fully justifies the supposition that the silica has been replaced by, rather than that a deposit of pyrites had taken place."

The diatom frustule is an exceedingly thin and fragile body, and it may be that a coating of pyrites has been deposited upon it by the reducing action of the organic contents upon a sulphate of iron. The coating may, perhaps, have adhered so firmly as to break up the valves into innumerable fragments when digested with nitric acid. It is evidently a question for the chemist, and one which is worthy of solution.

adequate to meet the demands of farmers for a supply of vaccine. In the space of fifteen days we have vaccinated, in the departments surrounding Paris, more than 20,000 sheep, and a large number of cattle and horses." These results of Pasteur were afterwards confirmed by independent experiment made by a commission of medical men at Chartres.

Dr. Klein considers it to be established that Pasteur's "vaccine" "when inoculated into sheep, produces some modified form of splenic fever that protects the sheep against the after-production of fatal splenic fever when the virulent material is inoculated into the sheep." He has not himself performed experiments on sheep, and is not acquainted with the particular details of the method by which Pasteur produced his "vaccine." Dr. Klein's experiments were performed upon rodents, such as mice, guinea-pigs, and rabbits; and whilst not doubting the "absolute reliability of M. Pasteur's successful vaccination of sheep with the *Bacillus anthracis*, and the immunity thus conferred upon them," his own observations lead him to question the applicability of these results to anthrax in other animals than sheep, and to other infectious maladies.

He cultivated these organisms in clarified soup, made from fresh pork; and he found that the formation of spores, contrary to the results of Pasteur's researches, was not prevented by exposure to atmospheric oxygen, but that spores were formed only upon the exposed surface of the nutritive fluid, and that as long as the cells were grown in deep vessels (test tubes) beneath the surface no spores were produced. He also found that a temperature higher than 43° cent. did not prevent spore formation when the cells by growing upwards rose into contact with the air. His experiments also differ from those of Pasteur in showing that when the modified virus is once obtained, it is not necessarily transmitted to the next cultivation. He states that when guinea-pigs and rabbits were inoculated with the *Bacillus anthracis*, cultivated artificially and prevented from forming spores, they took the virulent form of anthrax, and generally died; and that those which recovered from the disease did not preserve any immunity from the effects of subsequent inoculations. With mice it was somewhat different. They were peculiarly susceptible to true anthrax; but inoculations with successive cultivations of the bacillus were decreasingly fatal to them as long as spores were not formed, until at last an attenuated form was obtained which had no ill effect. If, however, this attenuated or harmless bacillus was allowed to come to the surface of the cultivating medium and to form spores, subsequent inoculation of the same mice with this material produced typical anthrax, from which they died. The gradually decreasing fatality from inoculations with the cultivated bacilli, when prevented from forming spores for many generations, was doubtless owing to the exhaustion

and death of these organisms, and their consequently diminished numbers; but spore formation, when allowed to take place in those that were still living, gave fresh vigour to the culture. Dr. Klein's experiments lead us to believe that spores are not formed in the blood-vessels of animals.

With regard to the mutual convertibility of the hay bacillus and the anthrax bacillus, which Dr. Buchner considers to be morphologically identical, although chemically and functionally distinct, Dr. Klein states that they never become identical in any sense or during any cultivation; and in this he is confirmed by Dr. Koch. Buchner cultivated the bacillus of anthrax, obtained from the spleen of a white mouse that had died of that disease, in a 0.5 per cent. solution of Liebig's meat extract, with or without peptone or sugar, at a temperature of 35° to 37° cent.; and he found that "the infectious activity of the fungus became the more diminished the more generations it had passed in the artificial cultivations." This result was not, however, always attained. In one series of experiments, he found that the second cultivation was active, the third and fourth inactive, the fifth active, and that activity was still manifested even at the thirty-sixth cultivation. Dr. Klein considers that the variability of Buchner's results is due to a variety of causes, the chief of which is the absence of spores from some cultivations and their presence in others. Dr. Koch explains these results by supposing that Buchner "may have had, and probably did have, in some of his cultivations, the *B. anthracis* originally sown, diluted or altogether suppressed by the growth of the non-pathogenic bacillus. He also maintains that when Buchner cultivated the hay bacillus in blood for many generations, and the animals died after inoculation with such blood, he did not produce the *B. anthracis*, but the bacillus of Koch's "malignant œdema."

It is to be hoped that future experiment may afford some explanation of the anomalous results of these researches of Pasteur and Klein, and that these observers may then be upon the track of the discovery of the true cause of the protective influence of vaccination.

A more detailed account of Dr. Klein's experiments will be found in an article written by him in the *Quarterly Journal of Microscopical Science* for last January, on "the relation of pathogenic to septic Bacteria, as illustrated by anthrax cultivations," as well as in the Supplement to the Report of the Local Government Board for 1881-2.

In view of the different opinions entertained by high authorities as to the significance of the presence of bacteria in fermentations, putrefactions, contagious diseases, and on the exposed surfaces of wounds, it would perhaps be premature to express any conviction as to the part which these organisms play in the various phenomena

to which I now allude. That they are not merely the concomitants of putrefaction and disease, I think there is abundant evidence to show, but to what extent they are the producing causes of many of the phenomena which have been ascribed to their agency, it would appear that further investigation is necessary to decide; especially when we consider the enormous multitudes in which the harmless bacteria are produced, the little that is known of their life-histories, the difficulty which the best observers have found in differentiating the minute and homogeneous forms, and the frequency with which other minute particles, organic granules, and even fat globules, have been taken for such minute globular organisms as *Micrococcus*, or the spores of the larger bacteria. It is even possible, as some writers suppose, that the smallest globular forms are merely the spores of the rod-like and filamentous ones; and that the latter are only different phases in the development of higher vegetable organisms, the life-cycles of which are yet incompletely known.

Some observers even profess to have traced the transformation of a *Micrococcus* into a *Mucor* or an *Ustilago*, amongst the true fungi; others claim to have witnessed the development of bacteria into yeast fungi, and these again into the form of *Penicillium*. This polymorphism has not yet been demonstrated; and all that is really known as to the transformations of the Bacteriaceæ relates to spore formation and development, and the different modes in which the cells colonise or group themselves. It is generally believed that true sporangia have been really seen in some species of Bacillus.

The Bacteriaceæ are found either as single independent cells, or united together in the form of chains or filaments, or imbedded in a gelatinous matrix, which serves to mass them together in a somewhat globular form. There are five forms in which these organisms are found attached to each other, or growing in masses.

1. The *Torula* form; caused by spherical, oval or oblong cells, after undergoing multiplication by transverse division, remaining attached to each other in a single constricted chain, like the cells of yeast.

2. The *Leptothrix* form; when a number of cells are united in a filament, not separated by constrictions.

3. The *Zooglœa* form; when spherical or oval cells, during rapid growth, are massed together in a homogeneous, colourless mucilage, secreted by themselves, forming a globular or irregular mass, sometimes several centimetres in diameter.

4. The *Mycoderma* form; when the cells unite to form a thick layer on the surface of the fluid, without an intervening mucilaginous substance; probably caused by a demand for oxygen.

5. *Swarms.* The spiral and filamentous species, when actively multiplying, appear in swarms; and as their motions are not im-

peded by a mucilage, they often swim very vigorously. They are sometimes found felted together in a motionless mass.

When the bacteria in any fluid have absorbed all the nutriment it contains, they fall to the bottom and form a precipitate; but, according to Cohn, they are not dead, and if a fresh supply of pabulum be added, they will rise and multiply.

The extreme minuteness of the smaller forms of the Bacteriaceæ, such as *Micrococcus*, especially those which do not exhibit movement, renders them very liable to be confounded with other particles, organic and inorganic débris of various kinds. Inorganic substances may be distinguished by their angular form, their inferior capacity for refracting light, their chemical reactions, and their molecular or Brownian movement. The discrimination of organic substances, which Cohn calls "pseudobacteria," is more difficult. Their form, however, is not so regular, their refractive power is less, and their colour variable. In doubtful cases, Tiegel recommends the slide to be warmed, when bacteria will exhibit characteristic motion, *i.e.*, in a straight or curved line, not molecular. Dr. A. Magnin gives the following arrangement of signs, after Hiller, for diagnosing bacteria:

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When we consider the number and variety of minute particles that have been found in the atmosphere, such as pollen-grains and spores of various kinds, fragments of insects, fibres of cotton, iron filings, &c., it would be surprising if the bacteria were absent. According to Cohn, Miquel, and others, the smaller forms of the Bacteriaceæ predominate.

M. Miquel found in the air of Paris that these organisms consisted of Micrococcus 93 per cent., Bacillus 5 per cent., and Bacterium 2 per cent. They were ten times more abundant in the streets of Paris than in the park at Montsouris. The proportion varied, however, with the height above the city. When 462 germs were found in a cubic metre of air, drawn through the tube of an aspirator, at the town hall of the fourth arrondissement, only 28 were gathered at the top of the Panthéon, and 45 at Montsouris. In rain water at the latter place they consisted of Bacillus 63 per cent., Micrococcus 28 per cent., and Bacterium 9 per cent. Whereas 64,000 were found in a cubic litre of rain water, only 900 were obtained from vapour condensed from the air, the river Seine at Asnières yielded 12,800,000, and the sewage at Clichy more than 80,000,000. They were least prevalent in winter, their numbers rose rapidly in spring, attained a maximum in the beginning of summer, and gradually sank in autumn. In hospitals they rose to an average of 5,600 per cubic metre of air in summer, and to more than 10,000 in autumn. A curve representing the weekly mortality in Paris was nearly coincident with one representing the number of atmospheric bacteria. Each increase of the latter was followed in about eight days by an increase of the deaths from contagious and epidemic diseases.

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Davaine in 1859 first clearly pointed out their vegetable character, yet there are many difficulties in the way of assigning to them their true place in nature, and of correctly estimating their physiological importance; and so long as our knowledge is confined chiefly to their vegetative system, and their reproductive system is either absent or imperfectly known, we must be content to look to the observers of the future for that fulness of knowledge which alone can satisfy.

ORGANISMS FROM THE RECENTLY DISCOVERED ROMAN BATH.

By R. H. Moore.*

In the Roman bath recently laid open to the city, the greater interest has centered in its archæological character—the lesser interest I am desirous to evoke this evening. As we gaze upon its noble fragments of architectural columns, its broken altar, its fine series of steps, and its substantial ambulatory, the imagination pictures former scenes of activity and enjoyment among an intruding race of men, which is in marked contrast with the present desertion and ruin of this once favoured spot. But so soon as desertion commenced and decay became apparent, Nature's deft fingers supplied the vacuum, and amid the ruins of man's industry she grasped the situation, and the site which had been busy with the haunts of man, and cheerful with the hum of conversational delight, became a world of tiny molluscs and waving rushes, land and water teeming with real but less apparent life. The remnants of this subsequent life I am desirous to bring before the society this evening. During the excavations on the site of the Roman bath last year, our fellow member, Mr. Bartrum, who was then Mayor of the city, introduced me to a bank of mud resting upon the floor of the bath, and situated immediately under the Poor-law Offices. From this bank of firm mud the organisms which I shall bring before you were selected. It was from eight to nine feet deep, and made up of clearly defined strata. At the bottom, upon the floor of the bath, lay the broken Roman tiles which once covered its roof, and thus all that was found above them must have been the accumulations of the centuries which intervened between the departure of the Romans and the decay of their noble work, and the more modern times when buildings became erected on the

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identical but (owing to the deposits) on the more elevated site. Above the tiles came a bank of firm black mud from five to six feet in depth, filled with thousands of fresh-water shells, their white forms contrasting with the dark earth so strikingly that even to an ordinary observer the bank was very attractive. Above this mud a stratum of vegetable deposit was found about two feet thick, black in colour, and moist and flaky in character. Another curious mass of vegetation lay upon the latter, greenish in colour, and light in weight, and under the glass it was principally composed of hollow fragments of a cylindrical shape. Above this stratum a mass of wood was found embedded in mud and sand, but as no rootlets were found the gentlemen who surveyed the spot considered that these were originally bundles of hazel wood thrown upon the marshy ground to form a foundation for the subsequent buildings which became erected upon the spot. Each of the branches was pressed out of the usual cylindrical to an oval shape, and was of a very soft and moist character. The whole mass of wood had evidently been used as fascines. Above this the foundations of the buildings commenced.

The Roman occupation of Bath probably ranged from A.D. 50 to A.D. 440. Coins have been found with Nero's inscription and with those of Trajan and Hadrian in various portions of our city. Wright, in his Bath Guide, states that probably A.D. 45 witnessed the arrival of a detachment of the 2nd legion to be stationed in this city, and he further states that in A.D. 120 Hadrian crossed over to Britain with the 9th legion, and installed a detachment of Roman soldiers in Bath. He alleges that the social and military works of the Roman conquerors were probably completed in A.D. 50, after two or three years' arduous labour, and he especially refers to the splendid Roman baths 20 feet below the present level of the city as among the constructed works of that date. After the evacuation of the city by the Romans, the noble handiwork of these foreigners remained probably until A.D. 577, when the Britons were overthrown by their Saxon conquerors, and it is interesting to trace the subsequent character of the site which only last year was so rich in organic remains, but which remains have been carted away to form a soil in some portions of the Royal Institution Gardens. After corresponding with Dr. Partridge, of the Stroud Microscopical Society, that gentleman visited the site of the bath, and received from me a section of the mud bank. He therefore consulted with Mr. Witchell, of Stroud, a Fellow of the Geological Society, and perhaps you will allow me to read his report upon the nature of the site and the character of the deposit:—

"In the deposits which immediately overlie the Roman tiles the physical condition of the valley of the Avon, following the period

of the Roman occupation, is clearly shown. It appears that on the departure of the Romans the country lapsed into its primitive state; the bed of the river, no longer kept in order, became dammed up by fallen trees, landslips, and the like, and the place where a high civilisation had existed became a shallow lake. The torrential streams of winter washed down from the neighbouring hills the surface-mould and decaying vegetation into the bottom of the valley, where it became deposited as mud, of which it formed successive layers, mixed with the river sediment and the fresh water shells. As a considerable portion of the strata of the hills around Bath consists of 'Fuller's earth' it is probable that much of the firm mud, which appears to be from five to six feet thick, was derived from the washing, by rain, of the 'Fuller's earth' slopes. The continuance of this deposit was certainly prolonged: as the quantity of matter deposited in any single year must be represented in its now compressed form by a very thin layer. Eventually these deposits ceased, and then the surface became adapted for the growth of rushes, in fact, it became a morass, and this condition of things prevailed long enough to allow of the deposit of decayed rushes to the depth of two feet. At the close of this period the river bed appears to have been cleared of its obstructions, probably by the hand of man, as the bed overlying the rush deposit is of artificial origin; the works of civilisation were again resumed and the surface of the river valley underwent a corresponding change. It is difficult, without personal examination, to describe with accuracy the physical changes that took place and which led to the formation of these deposits, but in all the river valleys of this part of the country, where the current is not very rapid, there must occur in the natural condition of things obstructions of the nature of those I have suggested as having occurred at Bath. In the valley of Frome, near Stroud, there are many flat meadows which owe their origin to similar conditions. The section is interesting inasmuch as it shows that a state of change still exists, that the operations of nature, under which the surface of the high lands is being denuded, are still going on, and where, as in the present instance, some of the results are capable of measurement, they are shown to be neither slight nor unimportant."

Beyond this opinion a large amount of interest centres in the probability that at one time the tide flowed up the river as far as the site of the bath. I am greatly indebted to Mr. Rimmer, F.L.S., of London, whose admirable recent book on "The Land and Fresh Water Shells of the British Isles" enabled me to correspond with him. He has not only been kind enough to complete the naming of the shells, which I shall presently show and describe to you, but he calls attention to one species which I found, not in the mud bank, but mixed with the sand and soil of the ambulatory

in great abundance. This species is known to inhabit only brackish water, and besides these shells some diatoms which I have found in the mud bank are really other than fresh-water species. Mr. Rimmer writes thus :—"The question, which is a very interesting one, arises, as to how these molluscs, *Hydrobia ventrosa*, came to be in a spot so far removed from 'brackish water,' which is their proper habitat. My own idea is that at some period the tide must have flowed up the Avon as high or perhaps higher than the city, and that in course of time an accumulation of *debris* carried down by the stream gradually formed a barrier which slowly but effectually checked its progress. Other causes, however, may have been at work; in any case the subject is, I think, quite worthy of the attention of your local geologists."

It now only remains for me to bring before you the contents of the mud bank I have described. The Mollusca form a sub-kingdom of the animal world, divided into—1, Acephalous without a head; 2, Cephalic having a head; the former division have Bivalve, the latter Univalve shells, and of the latter only I have to speak, because I have discovered no bivalve shells in the deposit of the bath. The Cephalic molluscs, Mr. Rimmer writes, "are of a higher organism than the Acephela, their nervous system is more fully developed, they have a distinct head, and usually tentacles or feelers on the tips, or sometimes at the base of which the eyes are placed. In some cases, however, the animals are eyeless." It is not my purpose to enter into their physiological structure, as the paper is only intended to describe certain forms which are found in the mud bank. Cephalic molluscs inhabit marine and fresh-water; they live on land, or, they may be amphibious. This description brings us to another division which is confined to those molluscs which dwell on land or inhabit fresh-water, and is termed Gasteropoda, and here we are introduced to two orders named Pectinibranchiata and Pulmonobranchiata, according to their breathing organs. The aperture of many of the univalve shells is closed by a curious appendage, which is termed the operculum, and which is attached to the foot of the creature by a strong muscle. The shells in the bank belong exclusively to the Gasteropoda, and among the first order Pectinibranchiata, there are a very few which belong to the first family of the Noritidæ. (I only found four). There is only one British genus in this family, Neritinia, and only one species, *N. fluviatilis*, and I have mounted three specimens, together with the operculum, which is peculiar in having on its under side a projection, which seems to keep the operculum in a proper position. The shell is prettily marked with purple bands, and you may notice the broad character of the inner lip of this shell. This mollusc inhabits rivers and lakes. The female deposits her capsules with from forty-five to sixty eggs upon the shells of neighbouring

peopled by a mucilage, they often swim very vigorously. They are sometimes found felted together in a motionless mass.

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to be stationed in this city, and he further states that
120 Hadrian crossed over to Britain with the 9th legi
installed a detachment of Roman soldiers in Bath. He
that the social and military works of the Roman co
were probably completed in A.D. 50, after two or thre
arduous labour, and he especially refers to the splendid
baths 20 feet below the present level of the city as am
constructed works of that date. After the evacuation of
by the Romans, the noble handiwork of these foreigners r
probably until A.D. 577, when the Britons were overthrown
Saxon conquerors, and it is interesting to trace the sul
character of the site which only last year was so rich in
remains, but which remains have been carted away to for
in some portions of the Royal Institution Gardens. Afte
ponding with Dr. Partridge, of the Stroud Microscopical
that gentleman visited the site of the bath, and received
a section of the mud bank. He therefore consulted v
Witchell, of Stroud, a Fellow of the Geological Soci
perhaps you will allow me to read his report upon the n
the site and the character of the deposit:—

"In the deposits which immediately overlie the Roman
physical condition of the valley of the Avon, following th

A much less robust species is *G. trichophylla*, the hair-pointed Grimmia, also fruiting in April and May. This is found on stone walls and the inflorescence is dioicous. Stems ¼—1 in. long, rooting at the base only. The leaves are linear-lanceolate, spreading from an erect base, and distinguished from *G. pulvinata* by their gradually tapering character and lax tufts.

In *G. torquata*, the twisted-leaved Grimmia, no flowers and consequently no fruit have been observed at any time; but jointed filaments, adhering to the back of a leaf, are frequently found among the leaves near the top of the stem. It is found only on alpine rocks in loosely forked tufts, one to two inches high. Leaves lanceolate-acuminate, spirally twisted when dry, channeled and occasionally hair-pointed.

Three very rare species are *G. Mühlenbeckii; G. leucophea*, the hoary Grimmia; and *G. unicolor*, the dingy Grimmia.

Close allies of the Grimmias, but with stems long and branching, are the *Racomitriums* or Fringe Mosses, so named from the lacerated base of the calyptra. *R. patens*, the tall alpine Fringe Moss, is found on moist alpine rocks in April and May, with branching stems two to four inches long. Leaves oblong-lanceolate, gradually tapering to a blunt apex; nerve strong and two-winged at back; this mark distinguishing the species, even when in a barren state; capsule obovate, furrowed when dry, on a pale curved fruitstalk; lid with a long beak and calyptra five-lobed at base. Dioicous.

R. protensum, the narrow-leaved Fringe Moss, grows in extensive light green patches on moist rocks by alpine rivulets, and fruits in April; as also the slender mountain Fringe Moss *R. sudeticum*, which is seen in loose grey patches on exposed alpine rocks.

Fruiting in June and July, on rocks near the sea, and in the Pass of Llanberis, &c., is *Glyphomitrium Davisii*, Davis' Veil Moss. Growing in dense dark-green tufts in crevices, its diminutive size renders it liable to escape observation, the stems being only ½ in. long and sub-divided. Leaves linear-lanceolate entire, margin thickened and reflexed below, strongly nerved to apex; areolæ minute; capsules erect, globose, with a reddish mouth and long rostrate lid; calyptra large, laciniate at base.

Of the *Orthotricha*, or Bristle Mosses, seven species are very rare and not likely to be met with by those only just commencing the study of Mosses, viz.: *Ulota calvescens, O. Shawii, O. obtusifolium, O. pumilum, O. pallens*, and *O. anomalum*.

O. tenellum, the slender-fruited Bristle Moss, is one of the most beautiful of the species, and is easily recognized by the narrow, elongated, golden brown capsules, which are strongly ribbed when dry, and by the narrow, glossy, yellow calyptras. Fruiting on trees in May and June, its stems are short and tufted; leaves lanceolate-oblong or ligulate; obtuse and pale green.

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O. Sprucei, found on trees near rivers in May and June, is a minute Moss with tufted stems only ¼ in. long.

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The fruit is rather rare, but we always find on the summit of some of the branches little cup-shaped receptacles, formed of broadly obcordate leaves, containing little spherical bodies (gemmæ), attached by a footstalk. The stems are elongated with ovate, acuminate leaves. The capsule of this and the next species has four only, erect, cellular teeth, from which the name was given by Hedwig; but Ehrhart named it *Georgia*, in honour of King George III., whom he describes as "an eminent patron of botanical study;" and this name has been adopted by Dr. Braithwaite in his Moss-Flora. Muller, in his synopsis, also retains the original name *Georgia*.

Tetradontium Brownianum, first discovered by the late R. Brown, Esq., at Rosslyn, is by no means common, and is found on rocks, generally of sandstone, growing chiefly on such as have their surfaces looking downwards.

A very peculiar and rare genus is *Buxbaumia*, named after a German botanist. The spores only escaping by the upper half of the capsule separating at a lateral seam, like a bivalve fruit.

B. aphylla, the leafless Buxbaumia, is without stem; the vaginula

thick and covered with radicles; bracts minute, brownish, ovate; deeply toothed; fruitstalk rigid, erect, straight; ½—1 in. high, deep purple, very scabrous. Capsule semiovate and somewhat boat-shaped above. This strange plant is found on the earth or on decayed wood, especially in fir wood, and fruits from May to July. It has an annoying habit of disappearing from the station it occupies; we can therefore never rely upon finding it a second time in the same locality; thus, its discovery is generally hailed with acclamation by collectors.

Another species found on rotten branches in pine wood in Scotland, is *B. indusiata*, with capsules more erect, and not flattened on the upper surface.

Allied to the genus *Atrichum*, and fruiting in June and July in alpine and sub-alpine situations where the soil is barren and sloping, is *Oligotrichum hercynicum*. Stems ½—1 in. high; leaves rather rigid, curved when dry, concave; the margin inflexed not thickened; capsule erect, ovate, cylindrical, broad and rounded at the base; lid about half as long as the capsule; calyptra with a very few scattered hairs, sometimes naked; peristome short, teeth pale irregular.

Two very rare Mosses, named after a German botanist and found on rocks in Scotland, are *Timmia Austriaca* and *T. Norvegica*. Named from αυλαξ, ακος, a furrow, and μνιον, a Moss, is the genus *Aulacomnium*. Like *Tetraphis* this genus is very seldom in fruit, the plant being continued by means of gemmæ at the apex of a short naked stem which tips the leafy stem. In *A. palustre*, the marsh Thread Moss, these gemmæ, or pseudopodia, are discoid in shape, while in *A. androgynum*, the narrow-leaved Thread Moss, they form a little greenish ball at the apex of the stem.

Leptobryum pyriforme, the golden Thread Moss, is found fruiting in May and June on sandstone rocks; its stems scarcely reaching ½ in. in height. The lower leaves are lanceolate, entire; upper linear-setaceous, flexuose; serrate at summit, nerve sometimes reaching apex; capsules pyriform, pendulous on a slender flexuose seta; lid convex-mammillate.

Bryum is an ancient name of the famous Greek botanist Dioscorides, given by Dillenius to a genus and its affinities, numbering forty-nine species.

They are perennial Mosses with terminal fructification, growing on the ground or on rocks; rarely on the trunks of trees, in dense tufts.

The capsules are pyriform, clavate or oblong, inclined or pendulous; smooth, with a tapering neck or apophysis; varying in length, on a long fruitstalk; annulus simple or compound; lid convex, more or less pointed, or sometimes shortly rostellate; calyptra small, cucullate, fugacious; peristome double; outer of sixteen

marine, and on one of the slides there is a perfect circular valve which can only be compared with *Coscinodiscus minor*, which is, however, a fresh-water species. The question again arises—How came the marine species in the deposit? Passing to the strata immediately above the firm mud which was purely vegetable, I have no hesitation in stating that the curiously serrated forms upon the slides which I have prepared are the silicious cuticle of the Dutch Rush, *Equisetum hyemale*, and probably those belonging to the *Avena fatua* or wild oat according to type slides which I have procured for comparison. The deposit has been treated with acid. In many of the slides there are numerous vegetable spores, which I am not able to identify as spores from the Equiseta. In the upper portion of the bank the light greenish tinged deposit appeared under the microscope, as before stated, to be composed of cylindrical and hollow organisms. After treating this with nitric acid in a boiling condition, the residue was found to contain a considerable quantity of diatoms, nearly all of them easily identified with the very abundant fresh-water species known as Synedra. The triangular-shaped ends of the *S. capitata* are very pretty objects, and those frustules which are devoid of these broadened extremities may no doubt belong to the *S. splendens*. In the morass there must have been numerous other forms of life which left no "prints upon the sands of time," but there remains yet another slide which will probably interest our worthy vice-president, Mr. Stubbs. The active little Cypris, of the Entomostracan group, led its merry life as usual at some time or another during the passing centuries, and I conclude with passing round one slide which contains the carapace or shell, and in the centre of the group there is one specimen with its delicate house still undivided.

The several deposits were mounted on glass and passed round the table, and all the shells described were named and mounted in small glass-top boxes. Drawings of a section of the mud bank in its several layers and the various organisms were distributed among the members. At the close of the paper, Mr. Bartrum moved a vote of thanks to Mr. Moore for the care and labour expended in the preparation of the subject so interesting to the city at the present time. The paper opened up many curious researches as to the physical condition of the early history of the site, and especially dwelt upon the theory of the influx of the tides. He could not think that the tide had ever reached the bath, notwithstanding the presence of the Hydrobia mollucs, and it would afford a matter for future research as to whether these creatures are really confined to brackish water. Major Davis, F.S.A., who was present as a visitor, was invited to take part in the discussion, and he gave an interesting description of his researches upon the

B. cæspiticium, *B. murale*,
B. erythrocarpum, *B. atropurpureum*,
B. apiculatum.

V. Leaves very concave, imbricate.

A. Capsules symmetrical.

B. filiforme, *B. argenteum*, *B. Funkii*,

B. mouth of capsule oblique.

Zieria julacea, *Z. demissa*.

VI. Leaves broad, roundish, bordered.

B. Tozerii.

VII. Leaves very large in a terminal rosaceous tuft.

B. roseum..

W. cruda, the alpine glaucous Thread Moss; *W. albicans* and *B. pseudotriquetrium*, fruit in June and July on mountainous banks and rocks. *W. carnea*, the pink-fruited Thread Moss, fruits in May on moist clay banks; while *W. nutans*, the silky pendulous Thread Moss, and *B. lacustre*, the small round fruited Thread Moss, frequent moist sandy places. *B. neodamense* is found on Southport sands, where it is liable to inundation; it is also reported as occurring in the East Highlands.

A very rare fruiting species although frequent on sub-alpine moist rocks is *B. alpinum*, the alpine purple Thread Moss. This is one of our most elegant species, and is usually known by the brilliant coloured foliage. The capsule becomes deep red as it ripens.

B. Muhlenbeckii is a doubtful species, and *B. Stirtoni* or *barbalum*, found by Dr. Stirton, is only recorded from Ben Ledi. *B. Sauteri* is another very rare and doubtful species.

The drooping Thread Moss, *B. pendulum*, is not infrequent on walls and rocks; and *B. inclinatum*, the small-mouthed Thread Moss, on walls, banks, and decayed trees: both fruiting in May.

Fruiting in June are *B. torquescens*, the twisting Thread Moss; *B. obconium*, the obconical Thread Moss; *B. Donianum*, Don's Thread Moss; *B. provinciale; B. murate; B. erythrocarpon*; *B. atropurpureum* and *B. Funkii*.

Conspicuous for their large size and broad leaves, being amongst the largest of the acrocarpous Mosses, is the genus *Mnium*, growing on the ground or on rocks in shady situations. They are distinguished from the Bryums by the mode of innovation of the stems, which is from the lower part; by the filiform paraphyses of the barren flower; by the texture of the leaves; and in general by the larger size of the species.

The leaves vary much in shape and disposition, often roundish—elliptical, spathulate, ligulate or more or less lanceolate, and are either serrated or entire, and with or without a cartilaginous border.

A. Leaves sharply serrated a margin cartilaginous.

M. affine, *M. cuspidatum*, *M. rostratum*, *M. riparium*, *M. spinosum*, *M. orthorhynchum*, *M. serratum*, *M. hornum*, *M. undulatum*.

b. without a cartilaginous border, *M. stellare*.

B. Leaves nearly entire, not bordered.

M. cinclidoides.

C. Leaves entire, with a cartilaginous border.

M. punctatum, *M. subglobosum*.

M. affine, the many fruited Thyme Thread Moss, frequents shady woods, banks, &c., but the fruit which ripens in June is rare. Stems one to three inches long; upper leaves very large, crowded, oval or oblong; the nerve ceasing below the apex; capsules ovate-oblong pendulous; lid convex, pointed: dioicous.

M. rostratum, the long beaked Thyme Thread Moss, is common on moist shady rocks and fruits in April. Stems ½—1 in., decumbent at base; lower leaves ovate; upper oval-oblong, obtuse, in a terminal spreading tuft, all simply and bluntly serrate; undulate, nerve slightly excurrent into a mucro; capsules oval, inclined or pendulous; lid with a long curved beak: synoicous.

M. riparium and *M. spinosum*, are two very rare species, and *M. cinclidoides*, the large-leaved Thyme Thread Moss, is only recorded from wet and boggy places on the mountains of Scotland.

M. serratum, the serrated Thyme Thread Moss, fruits in May and June on moist rocks and shady banks, especially in limestone districts. It is one of the smallest of the genus, having stems about ½ in. long; the beaked lid and synoicous inflorescence, distinguishing it from the more common *M. hornum*. The leaves vary from ovate to lanceolate; upper ones pale green, lower ones of a vinous red tint, especially on the nerve and cartilaginous border; capsule more or less cernuous; oval, reddish at the mouth.

Paludella squarrosa, the drooping-leaved Thread Moss, and *Mielichferia nitida*, are very rare, and do not fruit in Britain.

The lurid Cupola Moss, *Cinclidium stygium*, fruits in June and July on spongy bogs. It is rare in Britain, and frequently overlooked from its resemblance to *M. punctatum*, but the stems are more compactly tufted and matted together with purplish radicles. The inflorescense is synoicous, and from its deep red colour forms a most beautiful object under the microscope.

A rare Moss found on the sandhills at Southport and on boggy and marshy places, chiefly in the Highlands, is *Meesia uliginosa*, the dwarf meesia; while the stem is only ½—1 in. long; the fruitstalk is two inches in length with a capsule more or less oblong pyriform; leaves lanceolate, obtuse, entire; nerve thick, ceasing below the apex. Fruits July and August. Also at Southport and in similar situations in Scotland, is *Amblyodon dealbatus*, the lesser pale Thread Moss.

Of the *Funaria* or Cord Mosses, *F. fasciculare* and *F. calcarea* fruit in April and May. *F. microstoma* is very rare, occurring only at Maresfield, Sussex.

Entosthodon Templetoni, found in the crevices of rocks; fruits in July; and *E. ericetorum*, the narrow-leaved Fork Moss, fruits in March and April.

The genus *Physcomitrium*, or Bladder Moss, is named from φυσκη, a bladder and μιτριον, calyptra *P. pyriforme*, the common Bladder Moss, frequenting moist banks and ditches. Fruiting in April and growing in more or less extensive patches, the stems are from three lines to ½ in. long; lower leaves distant, ovate-lanceolate; upper leaves larger and wider, acuminate, denticulate; areolæ oblong-hexagonal, large; nerve ceasing near apex; capsule erect; roundish, pyriform; lid conical; calyptra pale, divided at the base into several segments.

P. sphæricum, the dwarf Bladder Moss, was found in Sept., 1834, by Mr. Wilson.

WILLIAM STANLEY.

(To be continued.)

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

ERRATA.—Page 160, line 8, for "handle" read "handles."
„ 160, „ 23, for "spherical" read "sub-spiral."
„ 163, „ 14, for Fig. 53 *s e.* "The hooks of the caudal disc may often be seen," read "Fig. 53 *s e*, (the hooks of the caudal disc may often be seen)."
„ 164, „ 9, for "ovary" read "wavy."

Also on page 176, line 10, after "when mounted in," add "*water, or* 147 μ *when the mounting medium is*" glycerine, &c.

A NEW MICROSCOPE STAND.—On our last visit to London, Messrs. Watson of Holborn showed us a new stand which they had just exhibited before the members of the Royal Microscopical Society. It is founded on Bulloch's Biological Microscope, to which the Editor gave special prominence in "Practical Microscopy." This new stand deserves to be seen by all intending purchasers.

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ick perception of details, as well as giving precise ideas of the agnification or minuteness of the objects seen.

For those who find a little difficulty in drawing a true outline of y object under view, a useful accessory has been devised, termed e Camera Lucida, by which a person, without the slightest knowlge of drawing, may trace an exact copy of any observation he ay wish to preserve. A very good substitute, however, and much eaper is the neutral tint reflector, introduced by Dr. Beale; a ıple form of which, made with a small piece of tin and an ordiry cover glass, was distributed by Mr. W. Stanley, F.R.M.S., to the members present.

He illustrated its use by drawing several objects, and also showed value in connection with the stage micrometer in determining exact size of the object, as well as the magnifying power of the ious objectives used.

In the senior division, Mr. E. Ward, F.R.M.S., was the demonıtor, his subject being Micro-crystallization. Crystallography is of interest for all, but especially is it of importance to the ysicist, the geologist, and the chemist.

Mr. Ward commenced with tartaric acid in water, then gallic d in methylated spirit, and hippuric acid in pure alcohol, orate of potash, both the dendritic forms and separate crystals, l concluded with asparagin or aspartic acid. Altogether about y slides were mounted and distributed.

STUDIES IN MICROSCOPICAL SCIENCE. Edited by ARTHUR ARLES COLE, F.R.M.S.

We have been given to understand that Vol. II. of these studies l commence on the 7th July, 1883. The work is to be divided o the three following sections, which will be paged separately so to suit the wants of the subscribers.

Section I. will commence with No. 1, on the 7th July, to be ıtinued in monthly numbers: it will open with a chapter on the rphology of the animal cell, and in addition to a complete set lithographed illustrations and microscopical preparations, will ntain ample references to other works and a large proportion of ginal matter. The remaining chapters will, we presume, be ıilarly treated, and close with full bibliographical notices. The rk will be continued monthly until completed, when it will form compendious treatise on comparative histology based on develop:ntal considerations. Examples are to be chosen both from rtebrated and invertebrated animals, and in this will it differ m the majority of text-books on the subject.

Section II. will treat of botanical histology, to commence with . 2, on the 21st July, 1883, and to be continued monthly there:er.

Section III., entitled "*Popular Microscopical Studies*," is announced to be conducted somewhat after the fashion of Vol. I. already published. Each number will contain a description of the object issued, a lithographed plate, and the methods of its preparation for microscopical study. We strongly recommend those who employ the microscope for intellectual amusement, to subscribe to this section, as it will certainly contain a series of the most beautiful objects for the microscope, and the letterpress will help the student to understand how to prepare kindred specimens.

Sections IV. and V., on "*Pathological Histology*, and *Microscopical Petrography*," we are sorry to say, will not be published, until the lists of subscribers can be completed; but we are glad to learn that they are rapidly being filled.

In extension of this notice we refer our readers to the Editor, from whom they may obtain a prospectus with full lists of preparations to be issued, etc.

AYLWARD'S CAMERA LUCIDA.—Mr. H. P. Aylward of Manchester is selling a very cheap camera lucida, which can be used with the eye-pieces of any maker, without requiring an adapter. The reflecting surface is a thin cover glass, which is made adjustable, in order that the instrument may be used with either deep or shallow eye-pieces.

HOMOGENEOUS IMMERSION LENSES.—A correspondent who has had considerable experience with these lenses writes:—"I don't know what cement Möller uses, but I have had his slides under cedar oil a good deal, and see no signs of deterioration. A friend has mounted a good many slides of bacteria with Hollis' glue, which appears to be quite proof against the oil. Ward's brown cement seems equally efficacious."

BIRMINGHAM MICROSCOPICAL SOCIETY.—*Excursion to Oban.*—The party will leave New Street Station at 10-30 p.m., on Friday, 29th June, by Pullman Sleeping Car, *via* the Midland Railway, arriving at Greenock at 8-30 next morning. Thence they will proceed by David McBrayne's new royal mail steamer *Columba* through the Kyles of Bute and Loch Fyne; thence by the Crinan Canal and ocean steamer to Oban. Breakfast will be served on board the *Columba* immediately on the arrival of the party at Greenock. It is expected to reach Oban about 5 p.m. on Saturday.

Arrangements have been made for the reception of the party at the *Great Western Hotel*, at Oban, which is of first-class reputation, while its contiguity to the sea-beach will be an advantage to the members, and will save time for excursions, &c.

The screw steam yacht *Aerolite*, of about sixty tons, has been

hired of Messrs. Ross and Marshall, of Greenock, for a week, commencing Monday, 2nd July; facilities will thus be afforded for dredging excursions, not only in the districts previously worked, but also in distant localities.

The time for the excursion will be from the 29th June to the 10th July inclusive, but members may return at any time during the month. The arrangements for the return journey on 10th July will be similar to those for the outward journey; but members may, if they prefer it, return by rail *via* Glasgow.

It is estimated that the expense will be a little over £13 13s. for the twelve days.

THE METHODS OF MICROSCOPICAL RESEARCH.—The first part of this work by John Ernest Ady was issued to subscribers on June 16th, and is but an introduction to that which is to follow. The work promises to be exceedingly interesting.

MICROBIA OF MARINE FISH.—At the zoological station recently established at Havre, L. Oliver and C. Richet have carried on an extensive series of experiments on the presence of microbia in the tissues of living fish. With one or two exceptions, they find these organisms universally present in the peritoneal fluid, the lymph, the blood, and, in consequence, in the tissues. They have all the characters of terrestrial microbia, and are reproduced in the same way, by division and by spores. They are most numerous in the peritoneal fluid, less so in the blood and lymph.

The most common form is that of bacilli, longer or shorter, endowed with oscillatory movements; they are coloured by ammonium picrocarbonate and by aniline pigments; some are provided with spores, either in the middle or at the extremity of the rod.—*See J.R.M.S.*, June, 1883.

ANILIN COLOURING MATTERS AS STAINING MEDIA FOR HUMAN AND ANIMAL TISSUES.—Dr. H. Griesbach discusses the value of anilin colours as staining media for human and animal tissues, and gives the results of his own experience. His paper is not capable of useful abstraction, being already in a condensed form, but the following brief account is given to call attention to its existence and to enable reference to be made to the original.

Anilin-yellow he considers unsuitable. *Säure-gelb*, colours bone a beautiful orange, tracheal cartilage and connective tissue lemon. In sections of the intestinal sac of *Unio* the epithelium is orange, muscle gold, glandular tissue brownish, and the nuclei of the cells are very clearly shown. Nerve-elements are not so well coloured, nor any isolated cells except gland-cells. It does not appear to be suitable for chromic acid preparations. *Chrysoidin* is useful for bone and all kinds of connective tissue, which it colours a bright yellow. Its best effect is with fresh preparations. *Bismarck brown*

has its best effect with nuclei (either alcohol or chromic acid preparations) and unicellular organisms, bacteria of all kinds, colourless blood-corpuscles, &c. *Tropæolin*, Y, o, oo, ooo No. 1, and ooo No. 2. The first is good for human spinal cord hardened in chromic acid, and alcohol preparations of bone, the others serve for connective tissue, cartilege, nuclei, and bone. The colours are lemon-yellow, straw-yellow, orange, orange-red, and brown. *Crocein* he has found to be a very useful medium. It colours bone, cartilage, muscle, and connective tissue (whether fresh or alcohol or chromic acid preparations) a beautiful purple-red. *Rocellin* colours bone and connective tissue, muscle, glands, and epithelium cherry-red. *Xylidinponceau*, *Ponceau* R R, G, and G G are not suitable for chromic acid preparations. The first gives good colours with bone, connective tissue, and muscle. The second gives red and scarlet-red colours. The third colours bone dark orange; connective tissue, muscle, and epithelium saffron-yellow; nerve substances bright yellow. The fourth has only been found useful for bone, gelatinous connective tissue, and muscle, which it colours a bright orange. *Bordeaux* R and G. colour the three last mentioned substances, nuclei, and glandular tissue, the former giving a red and the latter a more yellow tint. Fresh are less successful than alcohol preparations. *Biebrich scarlet* colours the most different tissues deep red. It is not suitable for chromic acid preparations. Cell-nuclei stand out sharply. *Gold-orange* serves for fresh or alcohol or chromic acid preparations. Bone is deep orange-red, cartilage gold, connective tissue reddish. It is especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels showing on a gold ground; sections of skin give fine images.

The preparations after washing and clearing are best mounted in balsam. Oil of cloves is mostly used for clearing. Very delicate colours are, however, often injured by the yellow of the oil of cloves, and in such cases oil of lavender should be substituted, or a quite colourless oil of aniseed.

Dr. Griesbach gives a word of caution against the too hasty abandonment of the older media in favour of the new anilin colours, pointing out in regard to their use in permanent preparations that our experience of their durability is not yet long enough. Whatever the future may bring, however, is this respect, they cannot fail to be of the greatest use in histology.—*See J.R.M.S.*, June, 1883.

MOLLER'S TYPEN- AND PROBE-PLATTEN.—The catalogue just issued by Mr. J. D. Möller contains a somewhat startling item—a "type plate" of 1600 arranged diatoms, the price of which is 1600 marks or 80*l.*! With 800 or 400 diatoms, 20*l.* and 3*l.* 15s. is asked.

Of the *Funaria* or Cord Mosses, *F. fasciculare* and *F. calcarea* fruit in April and May. *F. microstoma* is very rare, occurring only at Maresfield, Sussex.

Entosthodon Templetoni, found in the crevices of rocks; fruits in July; and *E. ericetorum*, the narrow-leaved Fork Moss, fruits in March and April.

The genus *Physcomitrium*, or Bladder Moss, is named from φυσκη, a bladder and μιτριον, calyptra *P. pyriforme*, the common Bladder Moss, frequenting moist banks and ditches. Fruiting in April and growing in more or less extensive patches, the stems are from three lines to ½ in. long; lower leaves distant, ovate-lanceolate; upper leaves larger and wider, acuminate, denticulate; areolæ oblong-hexagonal, large; nerve ceasing near apex; capsule erect; roundish, pyriform; lid conical; calyptra pale, divided at the base into several segments.

P. sphæricum, the dwarf Bladder Moss, was found in Sept., 1834, by Mr. Wilson.

WILLIAM STANLEY.

(To be continued.)

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

ERRATA.—Page 160, line 8, for "handle" read "handles."
„ 160, „ 23, for "spherical" read "sub-spiral."
„ 163, „ 14, for Fig. 53 *s e.* "The hooks of the caudal disc may often be seen," read "Fig. 53 *s e*, (the hooks of the caudal disc may often be seen)."
„ 164, „ 9, for "ovary" read "wavy."

Also on page 176, line 10, after "when mounted in," add "*water, or* 147 *μ when the mounting medium is*" glycerine, &c.

A NEW MICROSCOPE STAND.—On our last visit to London, Messrs. Watson of Holborn showed us a new stand which they had just exhibited before the members of the Royal Microscopical Society. It is founded on Bulloch's Biological Microscope, to which the Editor gave special prominence in "Practical Microscopy." This new stand deserves to be seen by all intending purchasers.

the potash, and the condition of the diatoms. I can lay down no positive rule regarding this, but can only recommend the experimenter to try again when he fails in the first essay."—*See J.R.M.S.*, June, 1883.

THE METHODS OF PREPARATION.—Both organic and inorganic matters require special methods for their preparation as a means of study. Thus, the processes of pulverisation, levigation, of slitting, and of grinding minerals and rocks, are beset with difficulties of detail, which, for want of suitable attention, prove to be insurmountable barriers to the tyro, whereas their observance but shows that he has made a "mountain of a mole-hill." So, also, the impediments to successful section-cutting, staining, and mounting are all traceable to a neglect of minute particulars, such as the wetting of the edge of the razor with spirit, the practice of drying the edge of the blade when it is set down for a few minutes, the use of a mordant previous to staining certain vegetable tissues, or the thorough dehydration of sections before they are mounted in Canada balsam or dammar solution.

In the opening pages of his work on the microscope, Beale makes the following observations: "Manual dexterity, although subordinate to many higher mental qualifications, is as essential for the successful prosecution of microscopic observation as it is for that of every kind of experimental science. It assists us in the discovery of new means of enquiry and in devising methods by which difficulties may be surmounted. Without skilful manipulation we can neither teach by demonstration facts which have been already discovered, nor hope to extend the limits of observation and experimental knowledge. It is not, therefore, surprising that many of the most important facts which have been recently added to microscopical science, have been discovered by men who had previously well-trained themselves in experiment—particularly in practical chemistry and minute anatomical dissection. Improvements in the practical details of manipulation almost necessarily precede an advance in natural knowledge, and invariably promote and expedite true scientific progress."

But although manipulative skill is a very necessary adjunct to microscopical research, an attainment of the understanding of the general principles of action at the outset, sometimes proves to be the most arduous portion of the work, and very often is the only impediment to success. Practice and perseverance, brought to bear upon previously gained knowledge, are the only royal roads to manual dexterity, and it thus becomes the duty of the instructor to point out, not merely what path ought to be taken, but the various pit-falls which everywhere surround the beaten track, and how best to avoid them.—*From the Methods of Microscopical Research.* ADY.

quick perception of details, as well as giving precise ideas of the magnification or minuteness of the objects seen.

For those who find a little difficulty in drawing a true outline of any object under view, a useful accessory has been devised, termed the Camera Lucida, by which a person, without the slightest knowledge of drawing, may trace an exact copy of any observation he may wish to preserve. A very good substitute, however, and much cheaper is the neutral tint reflector, introduced by Dr. Beale; a simple form of which, made with a small piece of tin and an ordinary cover glass, was distributed by Mr. W. Stanley, F.R.M.S., to all the members present.

He illustrated its use by drawing several objects, and also showed its value in connection with the stage micrometer in determining the exact size of the object, as well as the magnifying power of the various objectives used.

In the senior division, Mr. E. Ward, F.R.M.S., was the demonstrator, his subject being Micro-crystallization. Crystallography is full of interest for all, but especially is it of importance to the physicist, the geologist, and the chemist.

Mr. Ward commenced with tartaric acid in water, then gallic acid in methylated spirit, and hippuric acid in pure alcohol, chlorate of potash, both the dendritic forms and separate crystals, and concluded with asparagin or aspartic acid. Altogether about fifty slides were mounted and distributed.

STUDIES IN MICROSCOPICAL SCIENCE. Edited by ARTHUR CHARLES COLE, F.R.M.S.

We have been given to understand that Vol. II. of these studies will commence on the 7th July, 1883. The work is to be divided to the three following sections, which will be paged separately so as to suit the wants of the subscribers.

Section I. will commence with No. 1, on the 7th July, to be continued in monthly numbers: it will open with a chapter on the morphology of the animal cell, and in addition to a complete set of lithographed illustrations and microscopical preparations, will contain ample references to other works and a large proportion of original matter. The remaining chapters will, we presume, be similarly treated, and close with full bibliographical notices. The work will be continued monthly until completed, when it will form a compendious treatise on comparative histology based on developmental considerations. Examples are to be chosen both from vertebrated and invertebrated animals, and in this will it differ from the majority of text-books on the subject.

Section II. will treat of botanical histology, to commence with No. 2, on the 21st July, 1883, and to be continued monthly thereafter.

catch such fish as may have found their way out of the incubator.

Later on, when all the fry have hatched out and the empty egg-shells disappeared, the escape of the young fry is prevented, and their safe confinement to the incubator ensured, by suspending a smaller wire-bottomed tray *d* in the larger ditto *c*, just before the entrance to the spout.

Concerning the quantity of eggs to be placed in the tray, and afterwards of alevins to be kept in it, experience has shown that in the case of trout and salmon ova and fry, when the temperature of the water is 32° Fahr., 10,000 is not too large a number; whereas if the temperature is as high as 50° Fahr., the number should not exceed 5,000.

As the current flows right through the eggs, they sustain no injury from being piled up several layers in thickness. The culturist should, however, avoid touching or moving them as much as possible during the earlier portion of the incubating period; for until they have reached the "eyed" stage of development they are exceedingly sensitive and easily killed.

Whilst until then the removal of the dead and diseased eggs demands great care there is no danger connected with the operation, or with that of clearing away sediment from the time of the appearance of the eye-spots, and this absence of danger greatly facilitates the work.

After the defective eggs on the surface have been picked out with a pair of nippers the culturist takes hold of that end of the large tray which is furthest from the spout, gently tilts it up, and then quickly sets it down again.

Each time this operation is repeated, the rising current causes the eggs on their descent to be differently distributed, and there is thus little chance of any worthless ones escaping notice.

Should any sediment collect on the ova, it is cleared away by sprinkling them well with a watering can furnished with a fine perforated rose. Before this can be done, the water in the incubator must of course be drawn off, the syphon generally used for the purpose consisting of an India rubber tube, which is hung over the side of the outer division *b* of the hatching trough, and reaches to the bottom of the apparatus.

When possible, the cleansing process should be deferred till the eggs are eyed.

Another precaution the culturist should observe is not to raise the large tray *c* of the incubator until the salmon and trout alevins have partially absorbed their umbilical sacs.

In the case of the fish just named the yolk-sacs are at first very large, and if the tray were then by mischance lifted at all quickly they might be pressed by the strong current through the wire-netting-

hired of Messrs. Ross and Marshall, of Greenock, for a week, commencing Monday, 2nd July; facilities will thus be afforded for dredging excursions, not only in the districts previously worked, but also in distant localities.

The time for the excursion will be from the 29th June to the 10th July inclusive, but members may return at any time during the month. The arrangements for the return journey on 10th July will be similar to those for the outward journey; but members may, if they prefer it, return by rail *via* Glasgow.

It is estimated that the expense will be a little over £13 13s. for the twelve days.

THE METHODS OF MICROSCOPICAL RESEARCH.—The first part of this work by John Ernest Ady was issued to subscribers on June 16th, and is but an introduction to that which is to follow. The work promises to be exceedingly interesting.

MICROBIA OF MARINE FISH.—At the zoological station recently established at Havre, L. Oliver and C. Richet have carried on an extensive series of experiments on the presence of microbia in the tissues of living fish. With one or two exceptions, they find these organisms universally present in the peritoneal fluid, the lymph, the blood, and, in consequence, in the tissues. They have all the characters of terrestrial microbia, and are reproduced in the same way, by division and by spores. They are most numerous in the peritoneal fluid, less so in the blood and lymph.

The most common form is that of bacilli, longer or shorter, endowed with oscillatory movements; they are coloured by ammonium picrocarbonate and by aniline pigments; some are provided with spores, either in the middle or at the extremity of the rod.—*See R.M.S.*, June, 1883.

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strongly nerved, margin plain; perigonial leaves tapering, very acute, nerved to the apex.

Catascopium nigritum, the lurid Apple Moss, fruits near Southport in August, and is known by the dark-coloured or black globose capsules. Stems, 1 inch or more; leaves lanceolate, acute, margin reflexed, entire, nerved nearly to apex.

A natural group of Mosses is the genus *Splachnum*, Collar Mosses, the name, σπλαχνον, is borrowed from Dioscorides, and was originally used for a genus of Lichens, probably *Sticta*, and subsequently adopted by Linnæus for this family.

Fig. 55.

The capsules are very elegant, and furnished with a peculiar swelling at the base (apophysis). The leaves are remarkable for their soft, succulent, spongy habit, and are loosely reticulated, much contracted when dry. They grow on the dung of herbivorous animals, in a loosely cæspitose manner, and are perennial plants.

S. vasculosum, the large-fruited Collar Moss, occurs only in wet places in the more elevated parts of the Highland mountains, fruiting in July. *S. sphæricum*, the round-fruited Collar Moss, is dioicous, fruiting in May and June on dung in moist peaty places. Stems ½—1 in. long, soft and succulent; leaves roundish obovate, acuminate, scarcely serrate, lower smaller, nerved nearly to apex. Capsule subcylindrical; apophysis somewhat wider than the cap-

sule; ovate-globose, spongy within, not inflated, shining, dark purple, rugose when dry; teeth of the peristome yellowish; columella exserted when dry, capitate; calyptra small.

This species is liable to much variation in the leaves, in the length of the fruitstalk, and in the colour of the apophysis. Fig. 56.

S. ampullaceum, the flagon-fruited Collar Moss, is one of the most beautiful and curious of British Mosses, exhaling an odour, while drying, similar to that of tanned leather.

Growing on dung, and fruiting in May and June, it is less frequent on the mountains than in low situations; the stems being about an inch long, and foliage more or less crowded; lower leaves lanceolate; upper leaves twice as large or more, obovate or oblong-

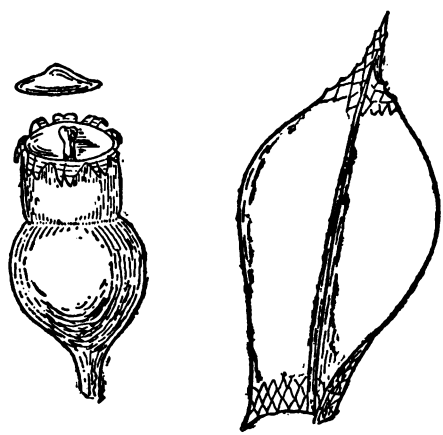

Fig. 56.

lanceolate, acuminate, more or less serrate, or entire; areolæ lax, nerved nearly to apex. Apophysis much wider than the capsule; hollow and inflated, pale purple or red. Capsule constricted below the mouth when dry; peristome inserted below the mouth of the capsule. Monoicous or dioicous.

Tetraplodon mnioides, the brown tapering Collar Moss, fruits in May, in moist mountainous situations, on dung or on decayed animal substances. Stem ½—3 inches, tufted; leaves sub-erect, obovate, suddenly narrowed into a long piliferous point; capsules oval, dark-red or blackish when fully ripe; apophysis at first green and narrower than the capsule, subsequently rather wider and longer.

T. angustatus, the narrow-leaved Collar Moss; *Tayloria tenuis*, the serrated Collar Moss; and *Dissodon splachnoides*, the marsh alpine Collar Moss are all very rare.

the potash, and the condition of the diatoms. I can lay down no positive rule regarding this, but can only recommend the experimenter to try again when he fails in the first essay."—*See J.R.M.S.*, June, 1883.

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roughly toothed point, nerved half-way, margins recurved; capsules roundish elliptical, drooping; lid with one oblique beak.

Anomodon longifolius, the long-leaved Anomodon, is found on Scotch mountains, but it does not fruit in Britain.

Leskea polycarpa is found at the roots of trees, usually near rivers. It fruits in May and June, and has ovate-acuminate leaves, strongly nerved almost to apex, margins reflexed; capsules sub-erect, sub-cylindrical; lid conical; monoicous.

Myrinia pulvinata, the green-cushioned Leskea, is found in similar situations, but is very rare.

Camptothecium lutescens, the rough-stalked Yellow Feather Moss, is found on limestone rocks and sandy banks, especially near the sea. Stems about 3 inches, irregularly branched, sometimes pinnate; leaves narrowly lanceolate, tapering to a long point, entire, nerved nearly to apex; capsules oblong-arcuate, in rough setæ, which with its conical-beaked lid readily distinguish it from its allies. It fruits in April, as also does *C. nitens*, the shining Feather Moss, an elegant species, but rarely found in fruit.

Brachythecium campestre, is only recorded for Maresfield, Sussex. Another rare record for Sussex is *Eurynchium hians*.

WILLIAM STANLEY.

A STANDARD BODY-TUBE FOR MICROSCOPES.

SOME time ago a committee was appointed by the Council of the Royal Microscopical Society to consider the subject of introducing a standard size for eyepieces, but the report of that committee has never been received with much favour by the vendors of microscopes. In fact, while the committee was sitting, several opticians declared to us that they would not alter the sizes of their tubes whatever conclusions the said committee should happen to come to, and therefore it seems that some other mode of working is necessary to ensure a standard size being carried out.

The committee, in its report, advised the adoption of "two standard gauges for eyepieces," "for the No. 1, 1.35 inches, and for the No. 2, 0.92 inch external diameter, and that the gauge for substages should be 1.5 inches internal diameter."

There is no doubt that a very general desire exists amongst workers with the microscope to have all the working parts of various makers interchangeable without the employment of adapters, and specially does this apply to oculars; and we see no other way of bringing about a standard gauge than by publishing the diameters of all stands now in the market, and advising purchasers to choose the largest bore. A small eyepiece will fit a *large tube*, and can be

centralized and kept tight by a paper adapter or collar made by the microscopist himself; but a small tube will only take a small ocular, and no other, so that the diameter of the body tube of the microscope should always be taken into consideration on the purchase of an instrument.

To help our readers in the selection of a microscope with a body tube of such a size as will take the majority of oculars now made, we append a table of the various eyepieces, measured with vernier callipers to the one-sixtyfourth of an inch. The measurement is also given of the neck of the ocular, over which the camera-lucida usually fits.

Name of Vendor or Maker.	Description of Model.	Diameter of Ocular.	
		Body.	Neck.
		inches & 64ths	inches & 64ths
Powell & Lealand..	Large Stand.....		
R. & J. Beck.....	National	1·17-64	57-64
Smith & Beck.....	Large stand.....	1·17-64	56-64
Ross & Co.	Ross-Jackson	1·20-64	57-64
Ditto	Ross-Zentmayer ...	1·20-64	57-64
Dancer.....	Large stand.....	1·17-64	57-64
Browning.....	Ordinary stand ...	1·17-64	54-64
Swift.....	Challenge	1·13-64	56-64
Collins.....	Harley.....	1·17-64	
Crouch.....	Premier	1·14-64	54-64
Ditto	Students		*
Aylward	Working	1·23-64	56-64
Parkes	Students	1· 7-64	*
Zeiss.....	Ordinary	58-64	*
Leitz.....	Ditto	59-64	*
Engelbert.....	Ditto	1·6-64	*

Upon those stands marked with an asterisk the camera-lucida is not made to fit in the ordinary way.

INSECT DEVOURING PLANTS.

By J. W. Gooch, M.R.C.S.

A paper read before the Windsor and Eton Scientific Society.

UNTIL comparatively recently, it was considered that one great difference between an animal and vegetable was, that the former had a stomach, and that into it food was taken there to be

digested and assimilated, but that plants had no such organ, but absorbed through their rootlets and through their leaves certain chemical substances from the earth and air, which were elaborated in the cells of their leaves and stems, and thus supplied food necessary for the growth and existence of the plants. It was afterwards discovered that certain foreign plants, such as Venus' fly trap and the pitcher plants, caught in their flowers flies and other insects, which in time became softened and then disappeared altogether, having actually been digested and absorbed by the cells existing inside the flower. Since then some of our common plants, such as we can procure in our immediate neighbourhood in the summer, have also been proved to have the same property, not, however, in their flowers, but in their leaves. It is to these, specimens of which I have here, I wish to draw your attention this evening. The most common of these plants is found at Burnham Beeches, close by the small pond at the extreme corner, in a damp, boggy situation; it is also found at Virginia Water, Bagshot Heath, and many other damp localities. The name of the plant is Lindew, *Drosera rotundifolia*, belonging to the natural order Droseraceæ, and nearly allied to the Violet tribe. There are three kinds of Drosera in England—the round-leaved, intermediate, and long-leaved. The plants when growing are very inconspicuous, for the leaves lie close to the earth, or are almost imbedded in mosses and other small plants growing about them.

. . . I have here two species of Drosera, the 'round-leaved' and the 'intermediate.' The tentacles are somewhat flattened, and are formed of several rows of cells, which surround a spiral vessel which passes through their whole length. The cells contain a purplish fluid, filled with granular matter, which under the microscope can be seen in constant motion. The glands themselves are covered with a glutinous substance, which is poured out from their cells, and to which insects stick. If a section of these glands be made and examined under the microscope, it will be seen to have an external layer of square cells, also filled with purplish fluid containing granular matter; beneath this is another layer of cells, then a few much longer cells, and in the centre a mass of much larger cells, each containing a spiral fibre, which is continued down the foot-stalk to the leaf itself. These stalked glands have the power both of secreting the glutinous fluid above mentioned, and also of absorbing the matter which has been digested. Directly an insect has been caught, a curious change takes place in the interior of the cells of the hairs and glands; the protoplasm and granular matter therein contained, instead of being spread out evenly, collects together into masses, and remains thus until the process of digestion has been completed and the leaf re-expands. The protoplasm then gets again dissolved and distributed evenly through-

out the cell. This process of aggregation begins at the summit and gradually spreads down the tentacle, but when digestion has completed the re-dissolving commences and proceeds upwards. Under a high power of the microscope a cell circulation can be distinctly seen. Mr. Darwin ends up his description of this process by saying, 'One of these cells, with the ever changing central masses, and with the layer of protoplasm floating round the walls, presents a wonderful scene of vital activity.' If any small object is placed on the extremity of one of the glands, it sticks to it, and soon, one by one, all the tentacles on the surface of the leaf will bend over, so as to quite envelope the substance. Among these specimens are many instances of this, upon some of which I have placed small flies or pieces of meat. The process is slow, for sometimes it takes more than four or five hours before the substance is completely covered in. Almost directly, however, the secretion is much increased in quantity, and not only in quantity, but also in quality, for it becomes much more acid, and this no doubt plays the greatest part in the digestion of the animal substances upon which it is poured. Pieces of meat placed in this fluid are apparently preserved by it, and remain quite fresh, for a piece put at the same time on the leaf of any other plant soon decomposes. Insects falling upon the leaves soon die, no doubt from the sticky fluid filling up the breathing pores and thus suffocating them. The roots of the Lindew are very long and slender, and seem only formed for fixing the plant to the surface of the soil, and also for sucking up the large quantity of water which is necessary to supply the secreting apparatus. Mr. Darwin says again in his work on 'Insectivorous Plants,' 'A plant of Lindew with the edges of its leaves curled inwards, so as to form a temporary stomach with the glands of the closely inflected tentacles pouring forth their acid secretion, which dissolves animal matter afterwards to be absorbed, may be said to feed like an animal.' It would seem that having a true digestive apparatus like ourselves, it has also the equivalents of a nervous system, for by no other method could sensation be transmitted from one hair to another; it has been proved that so sensitive are these hairs, that a piece of human hair only 1-120th part of an inch long, and weighing about one millionth part of a grain, laid upon one of them, caused it to bend over after a time, and so also will even the weight of a gnat's foot. The plant also seems to have reasoning powers, for if a drop of water is placed on a gland, it takes no notice of it, whilst a drop of milk or beef tea will cause instant inflection. Like the gastric juice of animals, the secretion from the glands contains an acid and also a ferment, and it is from this fact, and from the power they have of actually digesting animal substances, that the plants have been termed carnivorous or insectivorous. During the process of pouring out the

digestive fluid, a curious change takes place in the cells of the glands, the colouring matter which floats in a fluid, aggregates into a solid mass, which changes its shape in the same way as does the Amœba. It had for a long time been observed that the edges of the leaves of the plant called Butterwort were sometimes turned inwards, and that their sticky surfaces were covered with flies. Mr. Darwin counted as many as 142 insects on 32 leaves. The upper surfaces of the leaves are studded with glands supported on foot-stalks, and also smaller ones on much shorter stems. These glands secrete a glutinous fluid, so viscid that it may be drawn out into threads like a spider's web. The incurving of the leaf when digesting insects, no doubt serves to form a hollow, in which the fluid necessary for the purpose can be retained. The process of aggregation, as it is called, here also takes place in the glands when an insect is caught, in the same way as in the tentacles of Drosera. Speaking of the Bladderwort he said: "It was formerly supposed that the bladders, which often contain air bubbles, served the purpose of floating the plant at the surface of the water; this, however, is not the case, for even if all the air is pressed out of the bladders the plant still floats. As I see that the central cells of the whole of the plant, stem and leaves, are filled with air, this will account for its not sinking. The bladders themselves are about the 1-10th to 1-20th of an inch in diameter, and are somewhat oval and compressed, while at the upper part, a little to one side, is a mouth of a most beautiful construction. The opening of this mouth is horse-shoe shaped, and is surrounded by long branches, most delicate hairs, or tentacles. These hairs are perfectly transparent, and in their cells a distinct molecular motion can be seen under a high power of the microscope. There can be no doubt but that the office of these tentacles is to attract and entice minute creatures, for they are spread out like a net around the orifice. The valve itself is a most beautiful piece of mechanism; it consists of a transparent slightly convexed membrane, attached by its upper end to the walls of the bladder, but having its lower end free. It opens inwards, thus allowing anything to pass in, but entirely preventing its returning. On the upper and attached end of the valve are situated numerous glandular hairs, not unlike those on the leaf of Drosera, but much more delicate. They are also continued round the mouth of the bladder, and Mr. Darwin thinks their office is to absorb any nourishing fluids which may escape from the bladder. Other observers think that they secrete something which has the power of attracting insects, and certain it is that they are often seen feeding upon them, and returning again and again as if fascinated. In the knobs of these hairs protoplasm may be seen in constant motion under a high power. Towards the free border of the valve are situated four stiff but very delicate

hairs, which project upwards and outwards from the opening. It is supposed that their office is to protect the orifice, and thus prevent insects of too large a size from attempting to pass through. Still nearer the free border of the valve are five or six glandular hairs with very large knobs, placed on very short footstalks. The mouth of the bladder is very stiff and of a hard structure, and from it arise numerous delicate glandular hairs looking inwards, whilst there are several tentacles projecting from and extending outwards. On the surface of the bladders are numerous glands, the uses of which are not known; the same kind of glands are also found about the leaves and stems of the plant. All these glands and glandular hairs are better seen and rendered much more distinct if a little carmine is added to the water, when they instantly take a pink colour; the hairs in the diagram have been coloured to make them more easily visible. The internal structure of the bladder is most interesting. If a longitudinal section of one is made and examined under the microscope, it will be seen to be covered with innumerable hair-like projections. These are situated at the corners of the cells, and are quadrifid, that is to say, that from a common centre arises four hairs, two of which are long and two short. The two larger projections are directed upwards, and the two shorter towards the valve. The diagram represents some of these quadrifid processes situated at the end of a long cell. These hairs contain protoplasm in constant motion, and no doubt take the place of the roots of the plant, which are entirely absent. Each process also contains a large nucleus, which continually changes its shape. They absorb the contents of the bladders, which are destined to nourish the plant. Mr. Darwin thinks that no true digestion takes place within the bladders, as there are no glands present to secrete a gastric fluid; but that each insect caught decomposes, and thus each bladder, as it were, forms its own liquid manure, which the quadrifid process absorb. There is no doubt, then, but that the use of the bladders is to catch insects, and as many as from twelve to twenty of these can be counted at once in a bladder in various stages of decomposition, the last one entrapped perhaps being still alive and active. It is a disputed point whether insects force their way through the valve into the bladder, or whether the valve is or is not endowed with a certain amount of irritability, and that when touched it flies back and draws in the insect. . . . During the last fortnight, having obtained some plants from Burnham Beeches, I have been much interested in carrying out a few experiments, and have come to the conclusion that no creature small enough to enter by the neck of the bladder could of itself open the valve if the plant be freshly obtained and is in a healthy state. I tried to pass hairs, bristles, and even fine needles through, but could not succeed until the plants had become, as it were, weakened from being kept

in a small aquarium away from their natural conditions for a few days. The most common creature found in the bladders seems to be a small entomostracan, called Cypris, which is about the shape of an oyster, but moves about very actively. If one of these is watched feeding about the tentacles, mouth, and valve of a bladder, all goes well until it reaches a spot between the four hairs above mentioned and the free end of the valve, then it disappears like a flash of lightning, and can at once be seen swimming about in the bladder. If a stiff hair is mounted in a handle and the valve touched with it, nothing occurs until a certain spot be reached just beyond the four hairs before mentioned, when the valve suddenly snaps. One valve was lying just out of the water, and this I touched with the hair at the spot before described, when it flew open and instantly shut with an audible sound, resembling the discharge from an electric machine. It is a curious fact, too, that all the valves I tried refused to snap more than once, and not again until after a certain time had elapsed, as if requiring, as does the electric machine, a renewal of its charge. The snapping sound, too, I often heard when handling the plants out of water, when probably something touched one of the valves. It would seem as if the five or six large glands at the free end of the valve were concerned in its sensitiveness, for it is on touching them, or at any rate the valve in their immediate neighbourhood, that the movement takes place."

THE VINE-PEST IN ROSSENDALE.

By J. G. Lord.

IN a recent issue of one of the Manchester evening papers the following short paragraph appeared: — "The Phylloxera, an insect which has wrought so much devastation in the vineyards of France, has just been discovered in the extensive vinery of Mr. Alderman Lightfoot, Mayor of Accrington. For a considerable time past the vines have ceased to flourish, and Mr. Lightfoot spent a very large sum of money in a fresh bed, thinking that his old bed might be the cause. The insect is very small, but exceedingly destructive, and it is feared that the whole of the vines will have to be destroyed before the pest can be got rid of." The above paragraph, while probably read by the majority of people with slight interest, created quite an excitement among the gardeners in this locality, more particularly those having charge of vineries; and as I have been consulted in the matter, and have examined the vines at one or two places in the neighbourhood, resulting in the discovery of the pest, I thought that a short account of the insect and its ravages would be of interest to those

gardeners and gentlemen having vineries, who have not yet found out the cause of their failure in growing grapes satisfactorily. The *Phylloxera vastatrix* (the devastating phylloxera) is a very small insect, belonging to the order Hemiptera, to which bugs belong, family Aphidæ, commonly known as plant-lice, or green fly. The largest of the insects found at Accrington and in Rossendale, and in both instances they are the wingless brood, are not more than one-twentieth of an inch long, while the smallest of them will not measure more than one-fortieth or even one-fiftieth of an inch. Their antennæ, or horns, are short and many jointed, legs, as in all true insects, six, four jointed, with many short hairs, and having two small curved claws. The beak, which is situated on the under side of the insect, is long, and contains a tube made of three very long setæ or bristles, which when exserted are of considerable length. These are used by the insect to suck up the juices of the infected plant. The body of the insect is oval, and of a beautiful semi-transparent lemon colour; it has about twelve segments, and is covered with a number of minute prominences or tubercules. Altogether it forms, from a microscopist's point of view, a very pretty and interesting object. The aphides, to which phylloxera belongs, usually reside in large societies, upon almost every species of plant, but the different species of plant-lice, like the true lice of animals, are generally restricted to one or two particular plants. No part of the plant is exempt from the attacks of particular species, as they are found upon the young shoots, the buds, the leaves, the stems, and even the roots. Of these parts they suck out the juice by placing the beak in a perpendicular position, and forcing the included bristles into the tissues of the plant; the wound thus formed is frequently enlarged by movements of the body of the animal. Many species of these insects, especially those living on trees and shrubs, have two tubes on the abdomen through which a saccharine fluid is exuded, secreted by the animal. It constitutes the well-known honey dew, which drops in large quantities from some of our common trees (such as the lime tree), and forms small shiny spots upon their leaves. It is a well-known fact that ants and other insects of the same order (Hymenoptera) are very fond of this fluid, and seek the aphides for the purpose of sucking it from them; sometimes inducing them to excrete it by stroking them with their antennæ or horns, but sometimes biting and tearing them to get at it. Even more remarkable than this is the well-established fact that one species of ant keep plant lice in a state of slavery, so that they can "milk" them at their own sweet will. One French naturalist, in view of these facts, humourously remarks that the ants are a truly pastoral people. An account of the remarkable mode of reproduction of these insects must not be omitted from this paper, because it

accounts for the vastness of their number, when in other respects the conditions are favourable to their growth and development. The individuals found in spring and early summer, and which may be either winged or apterous, (not winged) are all of one sex, and give birth to others like themselves. During the whole of this time only these undeveloped females are met with, and generation follows generation, without the appearance of a single male. As many as from seven to ten, or even more broods, may thus be produced in a single season; so that from a single aphis it has been calculated that ten thousand million millions (Dr. Carpenter) may be produced in that period. In the autumn males and true females are produced, the former winged and the latter apterous; these perform the generative process, the females lay eggs, which, when hatched in the succeeding spring, give origin to a new brood, which repeats the curious life history of their predecessors. To those who have not studied Natural History the above account of their method of reproduction will probably appear incredible, but it is too well authenticated to be disputed; besides which, something similar takes place in other animals, notably in Entomostraca (waterfleas), a small animal allied to shrimps and prawns, in rotifera, minute wheel-animalcula, and also in the hydra, an interesting animal found plentifully in our ponds and ditches. The phylloxera, whose history and development we have traced above, during the time that males and the true females are found, live upon the leaves of the vine; as a consequence they curl up, their surface becomes covered with small brown tubercules, and frequently their attachment to the stem becomes so weak from lack of nourishment that they fall off. Afterwards the females move down to the roots, where they lay their eggs in the interstices of the bark, and on examination they may be found there in great numbers, often surrounded by a zone of eggs, which, I may say, are about half the length of the insect, and of the same beautiful hue. Many years ago this insect caused immense havoc among the vines in France, Italy, and Spain, but especially in France; whole districts were infested with it, and the grape crop was a complete failure. Hundreds of thousands of pounds damage was done in a single season, so that the revenue was seriously affected, and the Government took active measures to eradicate the obnoxious insect. Large rewards were offered for effective means of doing so; many plans were sent in, which we need not enumerate; suffice it to say that completely rooting up the plants in the infected districts and burning them seemed to be the only way of arresting the scourge. Some parts of our Australian colonies have been similarly affected, and the Government there, I believe, as a protection to non-infected districts, are insisting upon a like mode of procedure, indemnifying the cultivators for their losses. It has been known in England for

about 20 years, but does not appear to have caused such havoc as in foreign countries, probably because vine culture here is carried on under entirely different circumstances. The gardeners of this locality (and, in all probability, of other localities) have for some years past expressed very much dissatisfaction with the results of their labour and care in vine growing. With all their care, and with the most assiduous attention, the crop has been small and of poor quality, and in some cases there has been great difficulty in keeping the vines alive at all. In one or two instances fresh vines have had to be procured every three or four, or four or five years. It has been a matter of friendly controversy among them as to the cause of their difficulty—some attributing it to the soil, others to red spider, a small arachnid attacking the leaves; or to the weevil, a villanous beetle, which is certainly a great pest in this locality, as it is found in thousands in almost every greenhouse. The first supposition is disproved by the fact that in more than one instance fresh soil has been procured from Clitheroe, and still the vines showed the tuberculated leaves, and eventually failed to fruit as previously. The latter hypothesis has had most supporters, because there was the tangible fact of the presence of those insects, and certainly their presence in such vast numbers seemed to the most of them a sufficient cause for the state of the vines. The paragraph at the head of this paper, however, set one of the most intelligent and well-read of them thinking that, perhaps, here was a solution of their difficulties; he was so much interested as to go to Mr. Lightfoot's place and make inquiries, which confirmed his suspicion, as the symptoms were apparently identical with those shown by his own vines. He further brought with him some of the roots which had been dug up, and on returning to consult with some of the fraternity at Rawtenstall, was brought to my house, where the roots were subjected to a microscopical examination, resulting in the insects being found in great numbers. The following day, feeling himself sure of his case, he dug up one of the most affected of his own vines, and the day after I went to examine them. We overhauled them for a considerable time before finding anything but red spider, but at length first a few and then greater numbers of minute yellow insects were seen. To make assurance doubly sure that we had indeed got the dreaded phylloxera, the day following more roots were brought to me, with the result that these beautiful insects were found in the cracks of the roots, and crawling all over it in hundreds. Several were carefully picked off under a glass with a mounted needle, and compared on a glass slip with authentic specimens from Accrington, leaving no room for doubt that the principal cause of the difficulties under which the cultivators have laboured in this locality was the dreaded vine pest, *Phylloxera vastatrix*. As may be readily imagined, the

news rapidly spread among the craft, and by the time this appears in print will have caused almost a panic to every gardener within a radius of many miles. Just a word in conclusion in order to allay their fears. Firstly, from some of the above symptoms it is almost a certainty that we have had phylloxera in this neighbourhood for years, and yet grapes of fair quality have been grown. I allow that the vines have required great, and in some cases almost constant watching and attention, but with this there has been the above result; and, secondly, it is very probable that they will not prove so destructive in England as on the continent, on account of their different surroundings. I should therefore advise gardeners to take the matter as philosophically as possible; where grapes can be grown try to grow them, taking extra precautions, and exercising greater care than usual; and in autumn, when the males and females are found upon the leaves, then is the time to do so with some hope of success; then is the time to use the syringe with effect, bearing in mind the fact that one insect destroyed then, before the females descend to deposit their eggs, is as good as 100 or even 1,000 destroyed afterwards. If, in spite of everything, you are beaten, take satisfaction in having made a good fight; take out the roots and burn them, cart away the soil, make a huge bonfire in the border where practicable, and the longer you can let it lie empty the better, and after this, if the phylloxera wont go, you may know that it is time for you to do so.

NEW FORM OF ETHER MICROTOME.*

By Charles W. Cathcart, M.B., F.R.C.S.,

Lecturer on Anatomy, Surgeons' Hall, Edinburgh.

In venturing to add another to the many forms of Freezing Microtome which have been produced of late, I may begin by explaining what objects I had in view in devising the present apparatus, as a preliminary to describing its mechanism. These objects briefly, were—(1) to obtain a simple ether spray producer which would not allow any ether to escape unevaporated; (2) to have an efficient microtome for use with the ether spray, which would be so simple in its mechanism as to admit of manufacture and production at a comparatively low cost. After a considerable amount of time and trouble, I have succeeded in producing a Microtome which can be sold at 17s. 6d., including the spray

* "Journal of Anatomy and Physiology," vol. xviii.

producer, and which freezes ¼ of an inch of tissue in 1½ or 2 minutes, using in the process about 2 drachms of ether, which cost something less than a farthing. The instrument may be described under the heads of the Spray and the Microtome.

The spray producer works on the same principle as the scent sprays which have been in use for a long time, where a jet of air playing across the top of a tube draws up the fluid from its interior by tending to make a vacuum in it. The bellows used are the ordinary hand ones sold for carbolic and other spray producers, these being as cheap and efficient as any that can be got. In working at the spray points, I began by selecting the size of air-hole

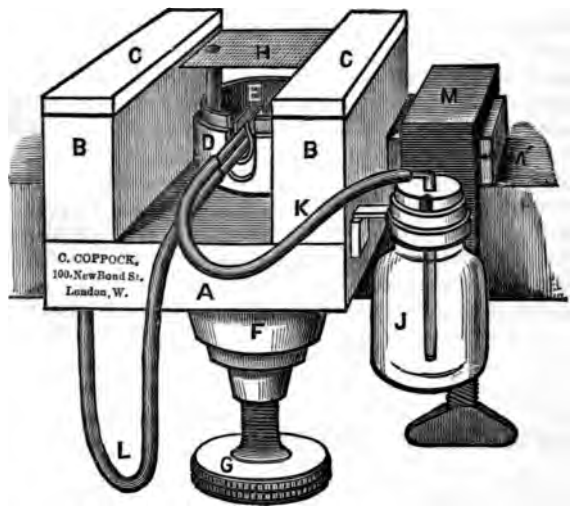

Fig. 58.

that these bellows could easily feed with a continuous blast of air, and then, experimenting with various sizes of vaccine tubes, I found at last, that with the smallest size I could produce a spray which, at about half an inch's distance from any object, contained just as much ether as the given blast of air could evaporate. There was then of course no running of the ether to waste, while at the same time an intense cold was very rapidly produced. The method of adapting the spray points to one another is a modification of the ordinary one, and is adopted from a German model. It is as follows:—Two fine brass tubes are taken—one is brought to the requisitely fine point for the ether, and the other, being closed at the end, has the air-hole bored at the side a little below the closure. The point of the ether tube is then placed over the middle of the

air-hole, and the tubes, laid one over the other, are soldered together in this position; the free ends of the tubes are then connected with the air bellows and the ether bottle respectively by means of india-rubber tubing, and this part of the apparatus is complete.

The microtome (see fig. 58) consists of the framework, and the mechanism for raising the section. The framework is of ½-inch mahogany, and is in the form of a base with two upright parallel pieces screwed on to it. The base (A), which is about 2½ by 4 inches, is bored to allow the tubes for raising the section to pass up between the parallel pieces, and has a projecting part at one side to allow of its being clamped to the table (M'). The two parallel parts (BB), which are of the same ½-inch mahogany, stand about 1¼ apart; they are 4 inches long, and, rising to 1 inch high, each carries on the upper surface a piece of ¼-inch plate glass (CC) of the same length and breadth as itself. This is to support and steady the knife as it is pushed across the tissue to be cut, while the fact of the tissue coming up between the plates allows that part of the knife which is to cut the specimen to be kept free of contact until it touches the tissue.

The method of raising the section plate is as follows:—About 2 inches of accurately-fitting double brass tubing are taken, and into the outer one (D) the nut (F) of a fine screw is firmly soldered at what is to be its lower end. The inner tube (E) has the section plate fixed to its upper end by two screws, with, however, two small pieces of vulcanite intervening between the plate and the tube, so as to disconnect them as much as possible, and into the lower end of the inner tube a transverse bar is fitted, against which the screw coming through the outer tube presses when it is desired to raise the section plate to which the inner tube is attached. By means of a small screw-nail fixing the outer screw to the bar in question, the inner can be withdrawn, as well as pushed up whenever that movement is required. A milled head (G) has been substituted for the ordinary capstan arms, for turning the main screw round.

The spray points are introduced at the requisite distance below the section plate by cutting a narrow slot through both tubes, and fixing to the inner one a piece of bent brass, into which the spray points can be pushed and held firmly, while a small shoulder on the latter prevents them from passing beyond the centre of the under surface of the plate.

Finally, the ether bottle (J) is fastened to the side of one of the upright pieces of the framework by a simple hook and eye, the hook being fixed to a collar round the neck of the ether bottle, and the eye to the side of the framework in question. It will be seen, I think, from this description, that with the exception of the fine screw for raising the tissue, the details of the mechanism are

very simple, hence the low price at which it can be sold; and in practice it has been found to work admirably.

MR. CATHCART'S DIRECTIONS FOR USE.

1. Place a few drops of mucilage (1 part gum to 3 parts water) on the zinc plate (H).

2. Take a piece of the tissue to be cut of about ¼ of an inch thickness, and press it into the gum.

3. Fill the ether bottle (J) with anhydrous methylated ether, and push the spray points into their socket (E). All spirit must of course have previously been removed by soaking the tissue for a night in water. It should afterwards be soaked in gum for a like time before being cut.

4. Work the spray bellows briskly until the gum begins to freeze; after this, work more gently. Be always careful to brush off the frozen vapour which, in a moist atmosphere, may collect below the zinc plate. If the ether should tend to collect in drops below the plate, work the bellows slower.

5. Raise the tissue by turning the milled head (G), and cut by sliding the knife along the glass plates.

6. After use be careful to wipe the whole instrument clean.

7. Should the ether point become choked, clear by means of a piece of fine wire.

8. The instrument is intended for use with methylated sulphuric ether.

9. In clamping the instrument to a table, or other support, care should be taken that the zinc plate is in a horizontal position. If the plate be not horizontal, the gum will tend to run to one side.

If, after the ether point has been cleared by the fine wire, it should still fail to act properly, it had better be returned to the maker for re-adjustment. For this purpose the spray points *only* need be sent.

At a temperature of 50° Fah., the instrument, if in proper order, should freeze a quantity of gum, half an inch in diameter and about one quarter inch thick, in two minutes. The instrument will give the best results when worked in a *cold* and *dry* atmosphere.

Mr. Coppock, of New Bond Street, is the maker of this instrument.

FOCUSING THE IMAGE IN PHOTOMICROGRAPHY.

IN pursuing the pleasing art of photomicrography there is no doubt that every operator has at one time or another of his experience had great difficulty in satisfying himself of the necessary sharpness of the image on the ground glass. Veterans of the art are known to have constructed appliances by means of which many of the difficulties may be bridged over; but the tyro is, as a rule, unacquainted with these so-called "little dodges," and therefore we purpose devoting a little of our space to the description of several methods for getting the exact focus of microscopic objects on the ground glass.

Dealing with low powers is not so troublesome as with high ones, as there is always sufficient light to enable a tolerably good focus to be obtained; but with high powers, and consequent loss of light, it requires all the skill at the operator's command to obtain even a passable picture in focusing by means of the ground glass alone. It has been the practice with some to use the finest ground glass obtainable, and to oil this over with olive oil, while others have discarded the use of ground glass as a focusing medium, and have thrown the pictures upon fine Bristol card-board placed in exactly the same plane subsequently occupied by the sensitive surface of the plate.

There is no doubt that the oiled ground glass enables the picture to be more accurately focused than when an unprepared surface is employed, but the want of light in the case of high powers is a difficulty not dealt with by this method.

Some years ago, Mr. J. B. Dancer described to us his method, which is as follows:—Draw two lines over the roughened surface of the ground glass from corner to corner, with a writing diamond, and in the centre, where the lines cross, cement a thin cover glass, three quarters of an inch in diameter, with balsam and benzol. This produces a transparent circle, and as aids other circles of a similar character may be dotted over the plate in the portion usually occupied by the picture.

Upon throwing the enlarged image upon a ground glass prepared as above, a little effort will enable the operator to distinguish the details of the picture upon the transparent portion, and in many cases, without any further aid, an exceedingly sharp focus may be obtained. In many cases, however, it is better to use an auxiliary microscope to examine this image on the transparent circle. Such an auxiliary microscope may be easily constructed: a piece of brass tube to hold the A ocular at its upper end, while the lower end is

fitted with the Society thread to allow a 2-inch objective to be screwed in. This combination is made to slide in another tube furnished with a set screw, in order that the inner tube carrying the optical portion may be fixed in any required position.

In use, the outer tube is placed in contact with the glass, and the inner tube carrying the ocular and objective withdrawn until the cross lines on the glass, made with the diamond, are exactly in focus. When the focus is accurately obtained the set screw is tightened, and it follows that when the lower end of the outer tube is placed over the transparent circles, the sharpest image must be in the same plane as the diamond scratches, when its details are best seen with the auxiliary microscope.

We can scarcely imagine a simpler or more accurate method than the foregoing, nevertheless, some may object to it on the ground that an auxiliary microscope is required, and therefore another method is given, which, if not so handy or so accurate as that already described, has the merit at least of being inexpensive. A focusing slide is used, in addition to the ground glass prepared as before described, and this slide is pierced with a series of holes to take an ordinary ocular, the A preferably. The first step is to secure the best focus on the transparent circle, *to the unaided eye*, and the proboscis of the blow-fly will be the best object to work with. When this is obtained, set the eye-piece in the position of

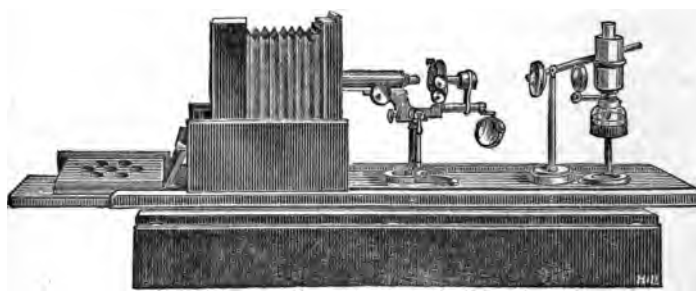

Fig. 59.

sharpest focus in the focusing slide, and always use it in that position, which can be ensured by a collar of sufficient depth fitting up to the shoulder.

This second method was first described in "Practical Microscopy," and Mr. G. J. Johnson's method of accomplishing the same end may be found on page 116 of the present volume.

For the benefit of those who wish to practise this art, we reproduce the illustration (fig. 59) showing the focusing slide at the extreme left of the base board.

FORAMINIFERA.

WE have lately received several slides of Foraminifera from various parts of the country on the sea coast, and, therefore, call attention to some notes on the subject in the July number of the Journal of the Postal Microscopical Society.

Mr. Charles Elcock writes that large quantities of Foraminifera abound in the little hollows between the ripple marks on the sand at Southport. A bit of newspaper being gently pressed into one of these hollows brought up no less than seventeen species, and it is probable that the ripple marks on other coasts may be made to yield a similar supply. The shelly *debris* from these hollows may be scraped up with a teaspoon to the depth of an eighth of an inch, and the Foraminifera floated from it. Mr. Elcock remarks that specimens would probably be found on every shore on our coasts, especially at low tides, those occurring in soft oozy mud appearing beautifully clean and lustrous when washed out.

In the same number Mr. J. W. Measures gives a description of the silt obtained from a depth of 23 feet at the Docks at Sutton Bridge, in Lincolnshire. Silt is a deposit, from a state of suspension in seawater, of sand in a state of extreme subdivision, loam, shells of Foraminifera and Ostracoda, and a small quantity of vegetable matter. The presence of Foraminifera shows it to be of marine origin. Mr. Elcock has examined this silt, and mounted a slide containing 48 species of Foraminifera from it. He speaks of it as being the most difficult raw material to manipulate he has ever met with.

In order to obtain Foraminifera from shore collections, dredgings, &c., the material must be washed with plenty of fresh water in a sieve, made of miller's silk gauze, 180 threads to the inch, and when the salt is washed out the whole thoroughly dried, and passed through a fine sieve having from 50 to 60 holes to the inch. The sifted material should now be placed in a round-bottomed basin holding three or four pints, and filled up with clean cold water, stirring well with a spoon, and allowing to stand for a minute or two for the sand to settle. The chambers of the Foraminifera being filled with air float on the surface, and may be easily transferred to a filter with a piece of card and a wash bottle.

For the information of those who wish to prepare fossil Foraminifera we refer our readers to Mr. Elcock's admirable paper in the September number of the Journal of the Postal Microscopical Society for 1882.

NACHET'S BLACK-GROUND ILLUMINATOR.*

INDEPENDENTLY of the use indicated by the author it is possible to employ this piece of apparatus as a means of procuring oblique rays with objectives of all powers from the No. 2 upwards.

When using artificial light, such as a paraffin lamp furnished with a shade, it is necessary to render the rays parallel by means of a bull's eye condenser, and by raising or lowering the source of illumination until a uniformly illuminated field is obtained. The obliquity of the rays is produced in a special manner, and sometimes the oblique rays proceed from all sides at once, lighting at one and the same time the upper face of the object which they skim over, and the lower face which they traverse.

This illuminator, however, without being very difficult to manage, requires, nevertheless, some care and management, especially in the adjustment of the cone of rays, the disposition of the mirror, and the intensity of the light. The effects yielded by the employment of this method will be sure to astonish all those who have only employed ordinary light for the examination of objects, or have only used condensers of the ordinary pattern. Thus, by this means, I have been able to see :—

1. With Nachet's No. 2 objective, and No. 3 ocular, the draw tube out, the two systems of diagonal striæ on *Pleurosigma angulatum.*

2. With objective No. 3 and No. 3 ocular the transverse striæ of *Surirella gemma*, which, without this method of illumination, required objective No. 5.

3. With No. 5 objective and No. 2 ocular, the longitudinal striæ on the same test.

4. And in employing the oculars Nos. 3 or 4 with the same objective it was possible to resolve very clearly the hexagons of Pleurosigma, and to see the longitudinal sinuous lines of Surirella in a much better manner than with the No. 7 immersion objective used without this illumination.

The results above described have been obtained so perfectly that persons completely ignorant of the disposition of the striæ have faithfully described and figured them without having previously seen any description or figure, and this enables me to state without the least doubt, or the least fear of error, that this illuminator, well managed, doubles in many instances the power of objectives.

B. BUSSEREAU.

* Note sur l' eclairage a fond noir de Nachet. Translated from the Journal de Photo. et Micr., &c. 8e Annee No. 2.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

COLE'S STUDIES.—Nos. 1 and 2 of the new volume have been issued, the first treating of the morphology of the cell being an introduction to Animal Histology, while No. 2 opens the subject of Botanical Histology.

THE METHODS OF MICROSCOPICAL RESEARCH.—This work is issued under the direction of Mr. J. E. Ady, as a preliminary to Vol. II. of the Studies in Microscopical Science. Two numbers have already appeared, the second on June 30th, and the series will be continued monthly until completed.

THE BIRMINGHAM SATURDAY HALF-HOLIDAY GUIDE.—A very handy guide of 74 8vo pages is published under this title at the *Town Crier* Office, 21, Great Charles-street, Birmingham. Its price is sixpence. Details of rambles to 39 places in the neighbourhood are given, the Natural History of the localities being well considered under the following headings :—Our feathered neighbours, Butterflies and Moths, Beetle hunting, On Spiders, and Land fresh water Shells, What the Microscope will show, The rarer Plants and Ferns, Our Moss flora, Geological rambles, and Fossil hunting.

LIVERPOOL NATURALISTS' FIELD CLUB.—We have just received the "Proceedings" of this Society for the year 1882-83, which contains the President's Address and an account of the Excursions and evening meetings. The President (Rev. H. H. Higgins) has given his readers an intellectual treat, extending over 42 pages, while Mr. Robert Brown has recorded the names of the more interesting plants, *noticed* during the excursions of 1882. It is satisfactory to note that the Club is in a very sound financial position.

THE JOURNAL OF THE POSTAL MICROSCOPICAL SOCIETY still keeps up its high class character; the resumé of Geological research by Mrs. A. Cowen in part 6 is valuable and interesting, while the chapter on the Methods of Microscopical research in the Zoological station at Naples will be found exceedingly useful by every preparer of micro-objects.

BACK VOLUMES.—During the past week we have been able to complete two Vol I. and one Vol. II. Subscribers requiring these, please apply at once.

AYLWARD'S CAMERA-LUCIDA.—Mr. Aylward has made a further

improvement in this important accessory, and it is certainly not the least of its advantages, that it will fit any ocular of English pattern. It can be made to fit foreign stands also.

GLYCERINE MOUNTS.—Much has been said against glycerine mounts and their leaky propensities after a lapse of time. We have lately seen some glycerine preparations put up ten years ago, and they are to-day as tight as when first mounted. The only varnish used for cell and cement was white zinc varnish: we have many glycerine mounts in our cabinet, and have come to the conclusion long ago that if every care were taken to clean away the superfluous glycerine there would be no more complaints of leakage. No cement will adhere where there is even the slightest film of glycerine.

MILK ANALYSIS.—A letter from Mr. J. B. Dancer in the Manchester *Guardian* of June 29th contains the following:—In a paper communicated by the writer to the Manchester Literary and Philosophical Society in November, 1859, the microscopical examination and some experiments on milk were described. Many years ago some milk was sent to the writer for examination from a public institution in this town, with a statement that something had been seen moving in it. On submitting it to the microscope it was found to contain numerous larvæ of the gnat and almost every variety of pond life, including algæ and confervæ, &c., it being evident that the milk had been adulterated with ditch water.

A ROYAL AUTHOR.—Prince Louis Ferdinand, a cousin of the King of Bavaria, who has already distinguished himself by extensive studies in more than one branch of science, has recently published a "Monograph on the Tongue," considered with reference to its comparative anatomy in man and in several kinds of other animals. Some of the microscopical and physiological investigations which have served as the basis of the work were conducted under Professor Rüdinger, and the remainder in the Prince's own laboratory at Nymphenburg. The work has 105 splendid illustrations, and is published by Theodore Riedel, of Munich.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the last meeting of this Society Mr. Cash exhibited the rare British Moss *Gymnostomum calcareum* in fruit, which hitherto had only been found in a barren state. The fruiting specimen had been gathered by Mr. A. Holt in Derbyshire during the present month.

Dr. Carrington placed upon the table a large number of letters from eminent Cryptogamic botanists who had been in correspondence with the celebrated Lancashire botanist, Edward Hobson. Many of the letters had reference to the collection of Mosses by Hobson, copies of which are now in the Free Reference Library and Chetham College. Dr. Carrington read numerous and in-

teresting letters, which included the correspondence with Caley, Wilson, Greville, Sir W. Hooker, Lyell, Bree, Schleicher, Dr. Taylor, John Dalton, and Sir William Jardine. The letters were placed in the hands of Mr. Cash for compilation and future reference.

MANCHESTER MICROSCOPICAL SOCIETY.—At the closing meeting of the Mounting Section of this society the report, read by the secretary, Mr. W. Stanley, F.R.M.S., was unanimously adopted.

The session has been highly successful both as to number of members and character of the demonstrations held, and the committee feel extremely gratified at the appreciation shown towards their efforts to provide an evident want.

Eight exhibitions of practical work have been held, covering nearly every department of microscopic work, and the valuable aid thus afforded to the junior members will doubtless prove of great benefit to the parent society, whilst those who may be considered as advanced students of the microscope enjoy at these meetings a fuller interchange of ideas, and a closer comparison of each other's work than is possible at the ordinary meetings.

Fifty members joined the section, and the average attendance has been 28.

The following gentlemen kindly officiated at the various meetings.

Mr. J. L. W. Miles—Dry, balsam and fluid mounts; white zinc cement ringing.

Mr. W. Stanley—Cell making and dry mounting. Glycerine jelly. Drawing with the Camera Lucida.

Mr. Lofthouse—Proboscis of blow-fly.

Mr. Doherty—Double staining of vegetable sections.

Mr. Mestayer—Cutting vegetable sections.

Mr. Attay—Cutting and staining animal sections.

Mr. H. C. Chadwick—Mounting in pure balsam without pressure.

Mr. H. P. Alyward—Dissection of the Cockroach.

Mr. E. Ward—Microcrystallization.

Micro-specimens for mounting have been distributed by Mr. Chaffers.

After a vote of thanks to the demonstrators, and also to the committee, the meeting resolved itself into a conversazione, at which various members exhibited work done by them during the session.

WINDSOR AND ETON SCIENTIFIC SOCIETY.—The monthly meeting of the Windsor and Eton Scientific Society was held on Wednesday, June 13th. There was a large attendance of members

and friends. A number of valuable books were presented to the library by Baron de Rottenburg, C.B., and Captain Ogilwy.

Mr. Gooch, the secretary to the society, read a paper on "Insect Devouring Plants," which was illustrated by specimens, diagrams, and microscopic slides. The paper, which was of a highly interesting character, may be found on page 220 of the present number.

The President said he thought all present must congratulate themselves on having heard such an excellent paper. Everyone acquainted with Mr. Gooch anticipated a paper beyond the common, and undoubtedly their expectations had been more than realised. Not only was the subject chosen an interesting one, but it had been rendered more than usually so by the original experiments which had been made, and the conclusions the lecturer had drawn from them. The President next referred to the fact that the English flesh eating plants appeared to have arrived at such a state of perfection in the matter of diet that they put to shame man with all his boasted reasoning powers, for they steadily refused anything that was likely to disagree with them. He was, however, somewhat relieved on reading the experiments of Hooker and others with the Dïonea, an American insect eating plant, which did not seem to have the same discriminating power as its English brethren, for it digested a variety of substances, and when a piece of cheese was placed on one of its leaves it readily closed over it, but the cheese was too strong for it, and instead of its digesting the cheese the cheese digested it, for the leaf soon turned black and died.

The Rev. E. Hale said he was requested to apologise for Mr. Carpenter's absence, who had intended to say a few words on the electricity of the plants so ably explained that night; but Mr. Carpenter would read a paper on the subject at another meeting. He might observe that when Mr. Darwin first called attention to the carnivorous habits of the Drosera, that he and Mr. Wolley Dod, an expert naturalist, made a series of experiments by way of testing the absorbing powers of the plants; the result was that the Drosera seemed to prefer beef to any other food which they administered—even to the fly.

Mr. Drew said he would only refer to the plants explained that evening in a geological sense. As the Cyprides, which were minute crustaceans, of the character of those mentioned by Mr. Gooch, abounded in the Wealden series, so much so as to divide the clay in some localities into distinct laminæ, he suggested as a possibility that close investigation of those rocks might lead to the discovery of impressions of plants, which required the Cyprides as food. Should any members present wish to work in that direction he should be pleased to furnish them with specimens of the Wealden.

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HYDRA: ITS ANATOMY AND DEVELOPMENT.

By J. W. DUNKERLEY.

AMONG the many myths which have come down to us from ancient times, there is one which says a monster with many heads, called the Hydra, infested the Lake Lerna. According to one authority (Diodorus) it had 100 heads; according to another (Simonides) it had but 50; while according to Apollodorus only 9 heads. It was said that as soon as one of these heads was cut off two others immediately grew in its place. It was one of the labours of Hercules to destroy this monster; and this he effected, with the help of Iolaus, who applied a burning iron to the wounds as soon as the animal was decapitated. The mention of an animal so much like the minute creature common to our ponds, that zoologists have given it the name of HYDRA, suggests that there might at one time have lived a much larger specimen than the one with which we are familiar, and which excited the wonder of the observers of former times; but it is doubtful whether it was large enough to be at all dangerous, and modern thought leads to the suggestion that the so-called labours of Hercules was simply one of those beautiful myths, founded on some known fact, by means of which the higher moral truths were inculcated in the past ages.

This little animal, the Hydra, was one of the first-fruits of microscopical research, and has been studied by a number of eminent men; it has probably had more papers written upon it than any other animal in existence. Leeuwenhoek, who was a close observer of nature, first took notice of it in the year 1703, and observed the uncommon way in which its young were produced. An account was communicated by him to the Royal Society, and made public in the 283rd number of the Philosophical Transactions. But its more amazing peculiarities were reserved for the inquisitive and happy genius of Trembly to discover, in the year 1739. This latter observer met with the Polype in his searches

after the minute inhabitants of the waters, and observing it in some respects to bear the semblance of a plant, and in others of an animal, he resolved, by cutting it to pieces, to satisfy himself which of the twain it was, and found by this trial, that each piece became a perfect body of the same form, exactly like that of which it only formed a part. This would have determined him to conclude it to be a vegetable, had he not discovered in it at the same time a frequent change of figure, and a motion from place to place, a greedy appetite, and a singular dexterity in catching, mastering, and devouring its prey, although much larger and seemingly

Fig. 60.

stronger than itself; circumstances which could leave but little doubt of its true nature.

Having satisfied ourselves that Hydra is a living animal, the first thing to be determined is its form and colour. But this wonderful little creature varies so much in its movements that it is difficult to ascertain the real shape at first sight, and the form of the body can only be determined when fully extended. They then vary from one quarter of an inch to one inch in length, according to their species, from the free end, numerous filaments which are often much longer than the body, spread out in graceful movements in search of food. If the animal is touched, these threads or tentacles rapidly shorten, and it shrinks into a round gelatinous

mass. It will remain attached to one spot for a long time, but it s capable of moving about, similar to that of the looping caterpillar, and at other times floats passively in the water.

Hydra is a tubular animal, and when found in water it is generally attached to a plant, such as duckweed, &c., or to other substances, as shown in fig 60. It is of simple structure, consisting of a body wall, which is composed of two membranes—an outer or ectoderm and an inner or endoderm—the outer wall being the protective and the inner the digestive organ. The tentacles are tubular processes of the sac, and also are formed externally by the ectoderm, and internally by the endoderm. The body and arms have a warty appearance, which are formed by large cells, around

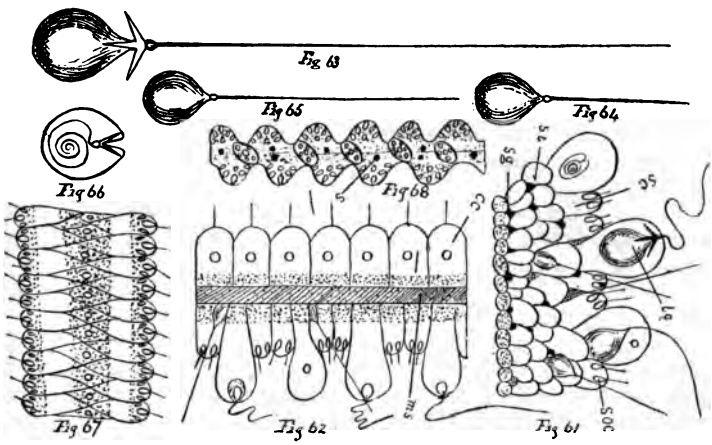

Fig. 61.

which are a number of smaller ones. Upon close examination of the outer wall, there can be seen the following: Fig 61 (l c), large conical nucleated cells, with the broader end turned outwards. (s, c) Smaller rounded cells, packed between the deep ends of the large ones. (s, o, c) Small oval capsules, with a filament coiled up inside them. (s, g) Small granules, consisting of a brown or black colour. Fig. 62 is a thin section showing the cells in the ectoderm and the filament uncoiled. (m, s) The thin muscular stratum between ectoderm and endoderm, sometimes called the Mesoderm. (c, c) The cells of the endoderm are large and nucleated, have a flattened edge, a rounded free end, are arranged in a single layer, and are ciliated. The Hydra possesses no sense organs or glands, and I may as well state for the benefit of the anti-vivisectionists that it can have no more feeling than a sensitive

plant. The cavity of the body alone represents a stomach, or anything that may be likened to an intestinal organ. There are no organs of circulation, respiration, or urinary secretion. When food is taken, the nutritive matter is quickly dissolved out and absorbed into the substance of the Hydra. The products of digestion are then transmitted by imbibition from cell to cell, and the waste of the cells is exuded directly into the water.

The mouth is situated at the anterior end, and when extended, forms a small cone. The opening of the mouth can easily be discerned when the animal is partaking of its food, for then its mouth dilates according to the bulk to be swallowed, which is often larger than the normal size of the animal.

The tentacles are arranged around, and just below the mouth. They differ in number and shape, and are hollow processes, which are closed at the anterior end by a small knob containing a number of thread cells. At the base they open directly into the stomach cavity. On the external surface the tentacles are very freely covered with thread cells, and when irritated by magenta staining, these threads are thrust out, and are found to consist of three forms.

First—Fig. 63. An oval or pear-shaped capsule with a filament many times its own length attached to one end, and three short spines at the base of the thread.

Second—Fig. 64. Smaller thread cells, without the spines, and with a short thread.

Third—Fig. 65. Cells like No. 2, but with a much longer thread. These threads, when not in use, are coiled up in their cells (Fig. 66), which have thick and elastic walls, and appear slightly tinged with a greenish colour. It is by means of these so-called threads that the Hydra has the power to sting or paralyze its prey. When these capsules, containing the threads, are heated with a solution of nitrate of silver, a portion of the silver is reduced to the metallic state. This action may be due to formic acid, which acts in a similar manner. These organs closely resemble in structure those of the Medusa, which possess an urticating power like stinging nettles, also arising from the presence of formic acid.

Fig. 67 shows the tentacles in a contracted state.

Fig. 68 shows that of expansion. Within the tentacles can be observed a protoplasmic fluid. When they elongate they become narrower and taper to the free end. At this time the contained fluid rushes upward, and the corpuscles (s) floating along beside them may also be seen. When contraction takes place, the fluid runs back again, the tentacles become wider and shorter; so much so at times that they can hardly be seen. How the elongation of the body and tentacles takes place is not yet understood.

The posterior part of the body is more or less dilated into a

flattened disc, which, by its suctorial power, enables the animal to attach itself to various bodies. No canal can be found in the disc, but it is slightly hollow, and has a dark appearance when in the flattened state.

There are three well known species. *Hydra vulgaris.* Body orange brown, yellowish, or red in colour; cylindrical in shape, having from seven to twelve tentacles as long or longer than the body, which, even when not extended, tapers to the free ends. This species is common.

Hydra viridis. Body, leaf green, cylindrical, or gradually narrowing towards the base. Has from six to ten tentacles, shorter than the body, and narrowest at their origin. This species is also common.

Hydra fusca. Body, brown, or greyish. Lower half suddenly attenuated. Tentacles five to eight in number, several times longer than the body. Rare in some parts.

Another, and very rare species, is the *Hydra attenuata.* Body pale olive green. Posterior part attenuated. Tentacles pale, and considerably longer than the body.

The green colour of *H. viridis*, and *H. attenuata*, undoubtedly results from the presence of chlorophyll grains, embedded in the protoplasm of the middle cells, although some writers express a belief that wherever chlorophyll is really found in the animal kingdom we have to do with green algæ living in the animals.

By various experiments I have found that the colour of all the species is much affected by light. Those which are exposed to direct sunlight become bleached. But upon placing them out of the rays of the sun the colour returns. I find that the best way to keep Hydra alive is to darken the bottom of the tank with cardboard about half-way up, so that if the Hydra prefers it can retire in the shade, and this proceeding also prevents the animal from burying itself in the mud.

Dividing *Hydra viridis* makes it lose much of its colour. The colour of all Hydra is also modified by the nature of its food. Laurent states that he succeeded in colouring them blue, white, and red, by feeding them with indigo, chalk, and carmine. I have, by colouring the water with indigo, carmine, etc., coloured the animal, and found it not only lived, but thrived well enough to bud. It will not, however, retain the artificial pigment, but will almost at once return to its original colour when removed from its influence.

(To be continued.)

NOTE ON A PINK TORULA.

By E. Klein, M.D., F.R.S.

SOME time ago I examined for my colleague at St. Bartholomew's Hospital, Dr. W. J. Russell, F.R.S., a sample of distilled water contained in a water bottle, through which 25 cubic feet of London fog air had been passing every hour for twenty-four hours. In this water were present, besides numbers of soot and dirt particles, large numbers of mycelia, or what appeared to be the mycelium of Penicillium and Mucor.

There were also present bacilli in the shape of longer or shorter, apparently smooth threads, and also a few ordinary torula cells, *Saccharomyces cerevisiæ*. With this water I inoculated a few test-tubes plugged with sterilised cotton wool containing neutral, or slightly acid pork broth, such as I used for other cultivation purposes, and placed them in the incubator at 32° C. After several days there was present in the test-tubes a fair amount of a whitish, or rather colourless nebulous sediment, which, when examined under the microscope, was composed of the most exquisite threads singly and in spiral bundles of the above bacillus. There were also present some short bacilli of the above kind; they were all non-moving. The bundles of spirally convoluted threads were identical with the typical cable-like bundles of *Bacillus anthracis*, and it would have been very difficult to recognise a difference at first sight; but they were not, of course, anthrax bacilli, as was soon ascertained by experiment. Besides these bacilli there were present in the culture numerous cells of the yeast *Saccharomyces cerevisiæ*. The cells are oval, consisting of a limiting membrane and a homogeneous, highly refractive protoplasm, and in it at one place one or two vacuoles. In some of them there was one large bright corpuscle present at one side of the protoplasm. In some the protoplasm appears slightly granular. The cells are of different sizes, some twice as big as others. Their sizes are as follows: the big cells 0.009 mm. by 0.01 mm., the small ones 0.005 mm. by 0.008 mm. The small ones are evidently young forms, since they could be seen to sprout out, and to become constricted off from bigger ones.

As regards the process of reproduction, it appeared to me to be that of gemmation only. Hereby large groups of cells, some chain-like, were formed, which groups by enlargement become soon confluent into larger masses.

The pork broth, kept at 32° C. for several weeks, became so concentrated, that when taken out of the incubator and allowed to cool, almost solidified. Keeping it in this state at the ordinary

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face of the solid nourishing material (gelatine), and this nourishing material is made fluid, so that the pink growth sinks to the bottom, and the material is again allowed to solidify: it will be observed that the pink mass retains its colour, that is to say, that the torula, once pink does not lose its colour when removed from the free access of air. But the new increment of the mass at the bottom of the now solid nourishing material is not pink, but colourless.

Schröter (Cohn's 'Beiträge zur Biologie d. Pflanzen,' ii. Heft. p. 112) mentions in a footnote that he observed occasionally on discs cut from a potato, mucous droplets of a pinkish colour, which, when examined under the microscope, were seen to consist entirely of *Torula cerevisiæ*. The cells were not coloured.

My friend, Professor Lankester, informs me, that when carrying on his researches on *Bacterium rubescens* in the laboratory of the Botanic Garden, Oxford, he observed a pink torula which spontaneously made its appearance in a test-tube containing Pasteur's solution.—*Quarterly Journal of Microscopical Science.*

A RAPID METHOD OF DEMONSTRATING TUBERCLE BACILLUS WITHOUT THE AID OF NITRIC ACID.

DR. HENEAGE GIBBES, M.D., who has attained a reputation for his excellent demonstrations of pathogenic bacteria, has given in the pages of the *Lancet* the following method of treatment for diagnostic purposes. "The stain is made as follows:—Take of rosanilin hydrochloride 2 grammes, methyl blue 1 gramme; rub them in a glass mortar. Then dissolve anilin oil 3 c.c. in rectified spirit 15 c.c.; add the spirit slowly to the stain until all is dissolved, then slowly add distilled water 15 c.c.; keep in a stoppered bottle. To use the stain:—The sputum having been dried on the cover glass in the usual manner, a few drops of the stain are poured into a test-tube and warmed; as soon as steam rises, pour into a watch-glass, and place the cover-glass on the stain. Allow it to remain for four or five minutes, then wash in methylated spirit until no more colour comes away; drain thoroughly and dry, either in the air or over a spirit lamp. Mount in Canada balsam. The whole process, after the sputum is dried, need not take more than six or seven minutes."

Dr. Gibbes states that this process is also useful for sections of tissues containing bacilli, as they can be doubly stained without the least trouble. He places the sections in the stain, and allows

them to remain for some hours, and then transfers them to methylated spirit, where they remain as long as the colour comes out. By this process beautiful specimens had been obtained without the shrinking which always occurs in the nitric acid process. Messrs. R. and J. Beck, 68, Cornhill, supply the stain, either in crystals or solution, ready for use.

THE PROCESSES OF LIFE IN PLANTS AND ANIMALS.

THE monthly lecture of the Windsor and Eton Scientific Society was delivered on Wednesday, the 11th July, when, in the absence of the President, who was on the Continent, Colonel Baron de Rottenberg, C.B., took the chair, and introduced Mr. P. H. Carpenter, M.A. The subject was, "The Processes of Life in Plants and Animals."

Mr. Carpenter said that he had promised Mr. Gooch, who described the Dionea at the last monthly meeting, to say a few words on the electrical changes which take place in plants; but circumstances prevented his being present, and he had been induced to give a lecture that night. Mr. Carpenter then proceeded to explain the peculiarities connected with the processes of life in animals and plants. The contraction of muscle and that of simple protoplasm differ, inasmuch that while simple protoplasm can contract or expand indifferently in any direction, the movement of the muscle is confined to one direction. The locomotive power of both animal and plant protoplasm may be separated into three kinds of movement:—1st, the Amœboid movement, so called, because it is typically shown in the Amœba or Proteus animalcule. This motion consists in the throwing out and retracting of blunt finger-like processes of sarcode. These pseudopodia, or "false-feet" can be projected indiscriminately from any part of the body substance—2nd, a streaming movement. This occurs in the perforate Foraminifera, the sarcode streaming out of one pore over the shell, and along any spines or excrescences which may be developed upon it, and through another pore into the interior mass of protoplasm, carrying with it any nutritious particles which it may have gathered while flowing over the surface of the shell.—3rd, a ciliary movement. This is a lashing motion of long delicate cilia or eyelash-like processes of protoplasm, which are more or less abundantly developed on the surface of all infusoria. The common slipper-animalcule, or Paramecium, is

thickly covered with these cilia which all wave in unison, like a field of wheat blown by the wind. This movement propels the animal through the water, and produces currents which bring it food. These movements, the amœboid, the streaming, and the ciliary, have their exact analogues in the movements of the protoplasm of plants. The Amœba has been always classed as animal, by reason of its deriving nutriment from ready-made protoplasm, but as its whole life history is not yet known, it is by no means certain that some, if not all amœba-like organisms may be the rudimentary forms or free cell contents of some of the lower plants. A fungus is found growing on the surface of tan-pits, which, at one period of its existence disintegrates, and the protoplasm of each of its component cells becomes a free organism, gliding over the tan in the pit by means of its pseudopodia, and exhibiting all the characteristics of an ordinary free amœba. Here then is an analogue of the amœboid movement. The streaming movement is exhibited by the protoplasm of the cells of the water plant Valisneria, which Mr. Carpenter said had been shown by Dr. Gooch at almost all the soirées of the society. In this plant the protoplasm does not fill the cells, but only lines them, and is in continual motion, streaming up one side of the cell, and down the other. The ciliary motion of the protoplasm of plants is typically shown in the little unicellular plant, known as Protococcus, the presence of which is the cause of the green colour of the water in gutters, &c. This plant consists of an oval cell, from one end of which two long cilia project, and the lashing movements of these cilia propel the creature through the water. The ciliary action is not confined to the lower forms of life; the gills of the bivalve mollusca, being thickly covered with cilia, the motion of which causes a continuous current of water to pass over the gills. Even the Vertebrata, including man, have certain organs covered with ciliated epithelium.

All the forms of protoplasm do not exhibit a continuous motion. Some require a stimulus, either by heat, a slight electric shock, or otherwise, to which they respond by movement. For instance, when an amœba comes in contact with a foreign body smaller than itself it immediately responds to the touch by closing round it. In plants this irritability is well exemplified by the action of the sun-dew. When certain hairs on the leaf of this plant are touched it immediately responds by the leaf folding in half along the midrib. Protoplasm, therefore, is said to be irritable. Another property of protoplasm is the power of taking in external matter, and the capacity of converting that matter into its own body-substance. Protoplasm is said, therefore, to be receptive and assimilative, and it is the possession of these functions which forms the great distinction between living and non-living matter. Lastly,

it breathes, that is to say, the presence of oxygen is necessary for its life. Recapitulating these points it will be seen that the chief properties and functions of protoplasm are: — 1st, contractility; 2nd, power of response to a stimulus, or irritability; 3rd, reception and assimilation; 4th, respiration. An important phenomenon connected with the movements of protoplasm, and the one which forms the chief subject of this lecture, is its manifestation of natural electric currents. If a fresh muscle of, say a frog's hind leg, be taken and connected with the two poles of a galvanometer, it is found that there is a continuous current of electricity passing longitudinally through it. During the contraction the natural muscle current is weakened or undergoes a negative variation. In nerves the effect is precisely similar, but the natural current is not so strong. During the passage of a nervous impulse along a nerve the natural nerve current undergoes a negative variation, just as in the case with a muscle in action. The same phenomena occur in sensitive plants. There is a natural current in the leaf of the dionea which undergoes a negative variation when the leaf is stimulated to contract by irritation of one of its sensitive hairs. But the latent period intervening between the moment of stimulation and the beginning of contraction is longer in the vegetable protoplasm than in the animal muscle. Similar electrical changes are produced when the stigma of Mimulus luteus is stimulated to contract. The conclusion of the lecture was devoted to an exposition of some recent researches into the functions of the green colouring matter of plants. The most important facts as pointed out were:—That until late years it was supposed that chlorophyll was the part of plant which performed the digestive function. It is now known, however, that chlorophyll has no power to decompose carbonic acid. The chlorophyll when dissolved out of plants and examined by the spectroscope is found to absorb all the violet rays of the spectrum. The chlorophyll acts as a screen cutting off those rays which promote the decomposition of protoplasm. The lecturer explained how hæmoglobin when dissolved out of the blood acts precisely as blood does becoming black in carbonic acid, and scarlet in oxygen.

The Chairman said he had heard Mr. Carpenter many times, but he had never listened to him with deeper interest.

Mr. Harris asked if any experiments had been made as to the condition of the movements in the stamens of the Berberidæ, and the leaves and petioles of the sensitive Mimosa?

Mr. Carpenter replied that he was not aware of any such experiments having been made yet, but that the subject was comparatively a new one, and also presented very considerable technical difficulties.

THE MINUTE STRUCTURE OF THE SPERMATOZOON OF THE NEWT.

By G. F. Dowdeswell, M.A.

(From the Quarterly Journal of Microscopical Science.)

THE general structure of the spermatozoon of the water Newt (*Triton cristalus*) has recently been well and accurately described by Dr. H. Gibbes.* It is to a point therein, which has hitherto escaped notice, that I wish here to call attention.

The spermatozoon consists, as described (loc. cit.) of the "body," to which is attached a fine, narrow, translucent membrane, bordered by what is usually termed "the filament," which takes its origin from what may be called the neck, the upper or thickest extremity of the body. This membrane and "filament" evidently consist of protoplasm, being highly contractile; in the fresh state rhythmical waves of contraction may be seen passing up them, and producing that remarkable appearance of spiral rotation, which in similar cases was often a source of perplexity to microscopists. The "body" also appears to be protoplasmic, both behaving in the same manner towards reagents, but the upper and thickest part, "the neck"—the "elliptical body" mentioned by Gibbes—appears to be of somewhat different constitution, as in some cases it stains much more deeply and readily than the rest of the body. Surmounting this, forming a cap as it were, is a long, finely tapering conical head, which, as already shown (loc. cit.), is of materially different constitution to the other parts, being apparently less stable, swelling up readily when treated with water, and being easily altered and destroyed by other reagents. It stains more readily than the body and membrane, but not so deeply as what I have termed the neck. Towards the extreme end, from tapering very regularly, the head becomes somewhat abruptly more constricted for the last few micras of its length, and is here, in unstained preparations, more highly refracting than the rest, its substance appears more dense; probably this end portion is solid and the remainder hollow (of which preparations stained with carmine present very much the appearance), and shows a double contour. At the extreme point of this head there is a minute barb. In successful preparations it may be very distinctly seen and readily measured, and this even when unstained. I have already† referred to its existence, and on further examination of better preparations

* Q. J. M. S., Vol. xix. (1879), p. 487.

† Q. J. M. S., Vol. lxxxii., N. S., 1882.

do not find it so ultra minute as I at first thought it. It is indeed of very appreciable magnitude, being in breadth about 1.5 micras (0.0015 mm.), and in length 2.0 micras (0.002 mm.), though obviously accurate measurements of such objects are difficult, for to detect the actual termination of an impalpably fine point is not always possible.*

Such a determinate and remarkable structure as that here described cannot be supposed to exist without some purposed recent researches at once suggest that this is to attach the spermatozoon to, and enable it to penetrate into the ovum in the early stages of fertilisation, as has been shown to occur by Fol and others; and we should expect to find a similar formation in other spermatozoa. In those, however, which I have hitherto examined I have not detected it, and the structure of many, as that of the toad, and of most mammalia, does not appear to admit of its existence.

To prepare the spermatozoa for the examination of this object the first essential is to get them as nearly as possible in contact with the cover-glass and flat upon it; this requires some care, to avoid their drying, by which they are materially altered. They may be preserved by several methods, either by treating for twelve to twenty-four hours with a concentrated solution of picric acid, a dilute solution of chromic acid, by Dr. Klein's method with a five per cent. solution of ammonium chromate, by iodine, by silver nitrate, or by osmic acid or gold chloride; the latter are convenient as being quicker. I have myself most usually employed picric acid. For staining I have found glycerine magenta † the best method, as it stains all parts as strongly as desired. To show the general structure alcoholic carminate of ammonia is the most satisfactory, but it does not stain the barb deeply. Other aniline dyes I have not found answer so well. If it be intended to examine the preparation with a homogeneous, or "oil" immersion objective, it should be mounted in Canada balsam, the objective having, as is generally known, no advantage, and, indeed, being inferior to dry

* In such measurements I have found great advantage in the use of a cobweb micrometer, admirably constructed by Messrs. Ross, which has the second web, which is usually fixed, movable; this both saves time and promotes accuracy, as in the usual form (with only one web movable) it is almost impossible, by means of the mechanical stage, to bring an object into exact contact with the fixed web, which is done at once with ease and certainty by the second movable one. Having now used this a good deal, I certainly prefer it to any other plan; whatever arrangement is adopted, however, it is necessary to determine the value of the scale of the eye-piece with a stage micrometer, as the least variation in the conditions of the instrument, as *e.g.*, slightly turning the screw collar of the objective, appreciably alters their relations.

† Magenta cryst., 1 part; glycerine, 200 parts; alcohol, 150 parts; aq., 150 parts; immerse the preparation in the solution for from two to four minutes according to the depth of colouring required, and then wash.

glasses for objects between which and the cover-glass there is either a film of air, or of any fluid the refractive index of which is much different from that of glass.

The use of glycerine as a mounting fluid for preparations stained with any of the aniline dyes is at best troublesome,* and sooner or later, to my experience, the staining runs, and the preparation is spoiled. Solutions of acetate of potash or chloride of calcium I have not found satisfactory; the form, even of such resistant objects as bacteria, in some cases becoming materially altered by these reagents. With Canada balsam, even when dissolved in chloroform or turpentine, I have not found the preparations fade, as has sometimes been said to be the case, and as we should have expected; nor, if they are sufficiently washed in alcohol and passed through oil of cloves, will they run; the risk, however, both of fading and running may be entirely obviated by using benzine as a solvent for the balsam, or by employing it undiluted and liquified by warmth.

In examining this structure I have employed the $\frac{1}{24}$th homogeneous immersion of Messrs. Powell and Leyland, which having the very high numerical aperture of 1.38° gives, with admirable light and definition, an amplification of about 3400 diameters, with an eye-piece of $\frac{3}{4}$ in. focal length; the barb, however, in a suitable preparation, may be readily seen and examined with a good $\frac{1}{8}$th objective. I have recognised it, even with lower powers, as the $\frac{4}{10}$th, dependent however much upon the method of illumination employed: for, as is generally recognised, good illumination will show an object with a much lower power than is requisite in the ordinary way. The best means of this as yet available is the direct light of the flame of a paraffin lamp turned edgewise to the observer, whether with or without a substage condenser.† This was recommended by Dr. L. Beale thirty years ago, and is now again frequently adopted. Light reflected from any mirror is in some way inferior to direct light, and this not owing to the double reflecting surface of ordinary mirrors, for I have tried them silvered on the upper surface without any material advantage.

* The method is, add an equal bulk of glycerine to the aqueous solution of the aniline dye used, stain somewhat more deeply than requisite, mount on slide with cover-glass in the staining fluid, which is to be gradually replaced as the water evaporates by plain glycerine.

† This may be found described and illustrated in Pritchard's Microscopic Cabinet of over fifty years ago, and in Ledermuller's Treatise of 1768.—ED.

NOTES ON MOSSES.

By William Stanley.

(Concluded from page 219.)

Pseudoleskea catenulata, the filiform Feather Moss, grows in dense patches about half-inch in height, on alpine and sub-alpine rocks; the leaves are very minute, being scarcely visible to the naked eye; widely ovate; acute, entire, concave, margin reflexed below; nerve broad, ceasing a little more than half way up; fruit not found in Britain.

Plagiothecium latebricola, the lurking Feather Moss, fruits in winter on moist shady woods on decaying trunks, and also old stocks of *Aspidium filix mas* growing generally in company with *H. denticulatum*, in yellowish or bright green tufts, with slender stems about quarter-inch in height; leaves ovate-lanceolate, tapering to an acute point, faintly two-nerved at the base; capsules elliptic-oblong, turbinate when dry; lid short, acutely conical. Two rare species of *Plagiothecium* are *P. Mühlenbeckii*, found on alpine rocks in Scotland; and *P. Silesiacum*, found only in Kent and in Yorkshire.

Amblystegium serpens, the creeping Feather Moss, is very common on walls, moist banks, trunks of trees, &c., and is known from its allies by its small size and slender habit, and by the small acutely tapering leaves, usually nerved half way; capsules oblong-cylindrical or obovate, cernuous, ripening in April and May; lid conical, acute. *A. radicale*, the long-stalked creeping Feather Moss, is found on moist ground amongst grass. *A. irriguum*, the rigid brook-side Feather Moss, is found on stones in rivulets and streams. *A. fluviatile*, the soft brook-side Feather Moss, is found on rocks and stones in mountain streams; and *A. riparium*, the short-beaked Water Moss, on stones near pools, sometimes in water. All fruit in April and May.

Four species, very rare, being found only on rocks, near the summit of Ben Lawers, are *Thuidium decipiens*, *Brachythecium plicatum*, *Heterocladium dimorphum*, and *Hypnum Halleri*.

With the exception of the first six species, the leaves of which are squarrose, the sub-genus, *Hypnum*, is distinguished by its falcato-secund character and narrowly linear areolation.

Of the squarrose section still unmentioned, and all fruiting in May, are *H. polymorphum*, the dwarf starry Feather Moss, found on limestone walls, banks and rocks, and in wet swampy places and bogs. *H. elodes*, the fine leaved marsh Feather Moss, and *H. polygamum*, the cluster-flowered Feather Moss.

In section II. the stems are pinnately branched; leaves falcato-

secund, nerve single; areolæ linear, and the following species are dioicous, with the stems and branches strongly hooked at apex. *H. aduncum*, the claw-leaved Feather Moss, fruiting in April and May on marshes and marshy heaths; also on swamps and marshes, *H. exannulatum*, its capsules ripening in June.

Found on bogs are *H. Sendtneri*, *H. vernicosum*, *H. Cossoni*, and *H. lycopodioides*.

Monoicous Mosses, with branches and stems scarcely hooked, are *H. fluitans*, the floating Feather Moss, and *H. revolvens*, the twirling Feather Moss, fruiting in April and May on bogs and marshes, &c.

H. uncinatum, the sickle-leaved Feather Moss, fruits in May and June on sub-alpine walls and rocks.

In section III. the stems are regularly pinnate and radiculose; leaves thickly nerved, opaque; capsules arcuate. The five species in this section fruit in April and May, and frequent marshes, wet rocks, &c. *H. commutatum*, the curled Feather Moss; *H. filicinum*, the lesser-golden fern Feather Moss; and *H. falcatum*, the falcate Feather Moss; *H. sulcatum*, and *H. virescens*, are very rare. *H. rugosum*, the wrinkle-leaved Feather Moss, is the only species in section IV. The stems are two to three inches, robust, without radicles; and irregularly pinnate; leaves lanceolate-acuminate from a broad base, dry, shining and strongly wrinkled or crumpled; areolation narrow and wavy above, the rest small quadrate; capsules sub-arcuate; lid rostrate, *annulus* broad. Found on limestone and other rocks, but barren in England.

In section V., *H. incurvatum*, the incurved Feather Moss, has stems creeping, cæspitose, and pinnate; leaves ovate-lanceolate, tapering, all pointing upwards, entire, shortly two-nerved; capsules small, ovate; ripening in June and July on shady walls and stones.

The species not yet referred to in section VI. are all very rare, viz.: *H. canaricuse*, *H. hamulosum*, *H. callichroum*, *H. Bambergeri*, and *H. imponens*. *H. patientiæ* is not uncommon on clay soils.

Section VII., *H. molluscum*, was described in the notes for last November, and section VIII., *H. crista-castrensis*, in those of the previous August.

In section IX., the stems are soft, cœspitose, prostrate and branched; leaves falcato-secund, faintly nerved, areolœ linear; capsules incurved cernuous; lids mammillate. With the exception of *H. ochraceum*, the yellow mountain-rill Feather Moss, which is dioicous and is found on stones in streams; all fruit in May and June, and are monoicous.

H. palustre, the marsh Feather Moss, is found on rocks and stones in streams. *H. dilatatum* and *H. eugyrium* are rare; and *H. molle*, the soft water Feather Moss, and *H. Arcticum*, the Arctic Feather Moss, are very rare.

Section X. has stems simple, more or less pinnate, erect or procumbent; leaves patent, thinly nerved or shortly two-nerved; areolœ linear; capsules incurved, cernuous.

H. cordifolium, the heart-shaped Feather Moss, inhabits marshes and ditches, fruiting in April and May. The stems are from three to six inches, erect, bright green above; reddish-brown below; leaves convolute and cuspidate at tip of branches; cordate-ovate, obtuse or slightly apiculate, strongly nerved almost to apex; capsules oblong, suddenly horizontal, not tapering at base; lid conical.

H. stramineum, the straw-like Feather Moss, although rare in fruit, is common in marshes amongst Sphagnum.

H. trifarium, the three-ranked Feather Moss, is found only in Scotland on alpine bogs and rills where the soil is turfy.

H. scorpioides, the scorpion Feather Moss, frequents bogs, but is not common in fruit. It is one of the largest species of the genus, having stems four inches long or more; leaves crowded, imbricate, falcato-secund, large, roundish-ovate, apiculate, entire, nerveless or faintly two-nerved; capsules short, oblong curved, cernuous on a fruitstalk two inches long; lid conical, pointed. Fruits in May.

Hylocomium splendens, the glittering Feather Moss, is frequent on grassy banks, in woods, &c., but rare in fruit, which ripens in April. The stems are two to six inches in length, erect, and bitripinnate; leaves roundish-elliptical, with long wavy points, serrate, shortly two-nerved, margin recurved below; capsules ovate, curved, cernuous; lid convex, tapering into a long beak; dioicous.

Neckera pennata, the feathered Neckera, is distinguished from the other British species by the immersed capsules, and by the inflorescence. It is very rare, being only found on the trunks of a beech tree at Fotheringham, near Forfar, and at Colin Glen, near Belfast.

Another Moss, with concealed capsules, is *Cryphœa heteromalla*, the lateral Cryphæa; it is found on trunks of trees; a variety, *B. aquatilis*, has been found on stones in running water. Stems one inch in length, sparingly branched, sub-pinnate; leaves spreading, imbricate, slightly recurved, broadly ovate, concave, margin reflexed, nerved above half-way; capsules unilaterally inserted, oblong; lid conical, pointed: synoicous.

FINIS.

THE PARCELS POST.

THE INLAND PARCELS POST being now in operation, and as it will obviously be a great convenience to microscopists for the exchange of slides, raw material, and apparatus, we give here an account of the same:—

In order that a packet may go by Parcels Post, it must be tendered for transmission as a parcel, and should bear the words "PARCELS POST," which should be clearly written in the left hand top corner.

CONDITIONS AND REGULATIONS.—The following are the principal: The size allowed for an inland postal parcel will be—

Greatest length...	3ft. 6in.
Greatest length and girth combined	6ft. oin.

For example:

A parcel measuring 3ft. 6in. in its longest dimension may measure as much as 2ft. 6in. in girth, *i.e.*, round its thickest part; or a shorter parcel may be thicker; thus, if it measure no more than 3ft. in length, it may measure as much as 3ft. in girth, *i.e.*, round its thickest part.

The most convenient mode of measuring will be by means of a tape 6ft. long, having the length of 3ft. 6in. marked thereon. So much of the tape as is not used in measuring the length will be the measure of the maximum girth permissible.

The rates of postage will be—for a parcel:—

Not exceeding 1lb. in weight	3d.
Exceeding 1lb. and not exceeding 3lb.	6d.
„ 3lb. „ „ 5lb.	9d.
„ 5lb. „ „ 7lb.	1s. od.

No parcel will be accepted which weighs more than 7lb., or is not sufficiently paid. The postage must, in all cases, be paid in advance, and by ordinary postage stamps, which must be affixed by the sender before tendering a parcel for transmission by Parcels Post at a post office.

POSTING OF PARCELS.—Parcels must not be posted in a letter box, but must be taken into a post office and handed over the counter. Care must be taken that every parcel bears a clear address. If a parcel be posted in a letter box it will not be forwarded by Parcels Post, but will be treated as a letter, or as a book packet if it can pass under book post regulations. The address of a parcel must be clearly written either on the outer wrapper or on a separate address label securely fastened to the parcel; and the necessary stamp or stamps, to pre-pay the postage,

must in all cases be placed (as in the case of letters) close above the address.

It is not intended to apply to postal parcels the practice which obtains of adding to the address, in the cases of letters for the Metropolitan Districts, the Postal District Initials, and such initials should not be used in addressing a parcel to London or the Suburbs.

The public will greatly assist the work of the Post Office, and help towards the safe delivery of parcels, by taking care that they are in all cases strongly and securely packed, especially those with fragile or perishable contents. It must be borne in mind, although of course every care will be taken by the officers, that such a parcel must be several times handled before it reaches its destination, and will probably have to be packed with many others of a different kind and shape, or more weighty and bulky.

FORBIDDEN ARTICLES.—Parcels which bear on the outside any writing or drawing of an indecent or offensive nature, or within which any contents of a like nature, may be observed, and parcels containing gunpowder, cartridges, lucifer matches, or anything explosive or liable to sudden combustion, bladders containing liquid, live animals, grossly offensive or filthy matter, and anything in a condition likely to injure other parcels, or any officer of the post office, are prohibited. If any such parcel be tendered for posting, it will be refused, or, if detected in transit, it will be detained. Parcels known to contain a letter, packet, or parcel intended for delivery at an address other than that borne on the parcel itself, are prohibited.

PERISHABLE AND DANGEROUS ARTICLES.—Parcels containing fish, game, meat, eggs, &c., or razors, scissors, needles, knives, forks, or other sharp instruments, will not be accepted unless securely packed so as to guard against risk of injury to other parcels. Liquids, or semi-liquids, such as jellies, pickles, paint, varnish, &c., will not be accepted unless in bottles or cans securely stoppered; nor powders unless so packed that they cannot escape in transmission. Bottles, or glass in any form, will be accepted only when so packed as to be secure from breakage. If a parcel be tendered in a damaged or insecure condition, or in a condition likely to injure other parcels, or any officer of the Post Office, it will be refused. If a parcel in such condition should be observed in transit, it will, if possible, be made secure and sent forward; but, if it cannot be so secured, it will be detained.

RETURNED PARCELS.—In order to facilitate the return of parcels which cannot be delivered, it is most desirable that the name and address of the sender should appear on the outside of every parcel. If a parcel which cannot be delivered bears on the

cover the name and address of the sender, a printed notice will be sent to him by post, informing him that the parcel (if not claimed in the meantime by the addressee) will be given up to him or to any person whom he may direct to call for it, or will be returned to him by post. If the parcel should be called for by the sender or his agent, or if it should be returned to him by post, it will be liable to a charge of one penny for each day or part of a day after the expiration of two clear days following that on which the notice has been sent. If the sender should elect to have the parcel sent back to him by post, he must return the printed notice, with stamps sufficient to cover new postage at the full rate and also to cover any other charges to which the parcel may be liable, including the charge of one penny a day described above. The parcel will then be forwarded to him prepaid by stamps affixed thereon. If no reply be received within six days after the date of the notice, or if the postmaster should have reason to believe that application is made for the parcel by a person who is neither the sender nor the addressee, nor duly authorized by either, or if the sender fail to pay the charges due on the parcel, the parcel will be sent to the Returned Letter Office. If a parcel which cannot be delivered does not bear on the cover the name and address of the sender, it will be sent to the Returned Letter Office where it will be opened and examined. If upon such examination the name and address of the sender are ascertained, a printed notice such as is described above will be sent to him, and the parcel will be treated in the same manner as a parcel upon the cover of which the name and address of the sender appears. If the name and address of the sender cannot be ascertained from the examination of the parcel, the name of the addressee of such parcel, and the post office at which it was posted will be entered on a list, which will be exhibited in a conspicuous position at the returned letter office of the district for inspection by the public. Personal applications for parcels entered on such lists will be entertained for three months from the date of entry, after which the parcels will be finally disposed of.

FISH-HATCHING AT THE FISHERIES EXHIBITION.

By W. Blackburn, F.R.M.S.

AMONGST the most interesting features of the Exhibition are the various apparatus for hatching and rearing fish. Here fish may be seen in all stages of development; the ovum without any apparent signs of life, or in some instances with two black spots just visible to the naked eye, indicative of the growing organs of vision of the inclosed embryo; the newly hatched fry, with the umbilical vesicle attached to it and affording it a temporary supply of food until it becomes capable, by further development, of maintaining the struggle for existence by the exercise of its senses; and the perfect fish, with trained eye and muscle, ready to make the best of every condition of its environment.

The microscopist who takes especial interest in the early stages of the fish development is naturally desirous of possessing some simple means of keeping the ova in a healthy state for observation and experiment; and this, in the case of ova that do not float, can be secured only by a constant supply of water running over them.

The simplest contrivance for this purpose appears to me to be "McDonald's Universal Hatching-Jar," patented by Mr. Marshall McDonald of Washington, U.S.A. It consists of a glass jar, 15 inches high and 6 inches in diameter, to hold five quarts of water; and it can be filled two-thirds full of eggs with safety. 60,000 ova of the shad are not too many to place in it at one time. It is covered by a cap of metal, through the centre of which a glass tube, for the inflow of water, passes nearly to the bottom of the jar. Another glass tube, shorter than the former, passes through the cap near the side of the jar, and serves as an outflow pipe. This pipe, the lower end of which is usually some distance above the eggs, can be lowered at discretion so as to be brought into contact with any dead eggs, which, by reason of their comparative lightness, may have risen above the rest. Dead or decaying eggs are thus carried away, and fungoid growth is prevented. The inflow of water, striking the bottom of the jar, is deflected upwards around its sides, carrying the eggs with it; these then move towards the centre of the jar, and fall until they come again into contact with the upward current. This current must be regulated to give suitable buoyancy to the eggs. The heavier kinds, like those of the salmon, do not move with the current, but are merely relieved from the pressure of those above them.

This apparatus need only be seen at work for its simplicity and excellence to be duly appreciated; and those who, like myself, have succeeded, after much trouble, in hatching fish ova under a domestic water-tap, will thank Mr. McDonald for his useful invention.

DOUBLE STAINING NUCLEATED BLOOD CORPUSCLES.

DR. VINCENT HARRIS has been experimenting upon this subject; a great many colours have been used in combination, and from his experiments he draws the following conclusions. The details of the various trials may be found in the last April number of the Quarterly Journal of Microscopical Science :—

1. The only entirely successful combinations were the following:

Rosein and anilin green.
Fuchsin and methylen blue.
Fuchsin and Bismarck brown.
Eosin and vesuvin.
Iodine green and Bismarck brown.
Hoffman's violet and Bismarck brown.
Anilin violet and methylen blue.

2. The green dyes were not at all permanent. I have proved this with both malachite and iodine greens.

3. Even with the above successful combinations the results varied in a most extraordinary manner, whilst the circumstances of the staining operation and the solutions appeared to be unvaried, the very greatest care being required to produce a constant result. One thing necessary for success was certainly that the solutions should be quite fresh. This is likely to prove a great objection to the general introduction of anilin dyes into use. The simple method of dehydration employed, of course, could not be employed in the preparation of tissues, although it does for blood, sputa, &c.

4. The result was materially affected by the time each dye was allowed to remain in contact with the blood.

It is worthy of note that according to the evidence of competent authorities, various chemically diffused anilin dyes have been sold under the same commercial name; and so, both in the preceding notes and also in the annexed table, it should be said that the anilin dyes used were obtained from Messrs. Hopkins and Williams, Hatton Garden, W.C. The following table (drawn up August, 1882) includes the dyes used in above experiments:

CLASSIFIED LIST OF THE CHIEF ANILIN DYES, WITH THEIR SOLUBILITIES IN WATER AND IN SPIRIT.

BROWN.	RED.	ORANGE.	YELLOW.	GREEN.	BLUE.	VIOLET.
Bismarck—partially sol. in water; sol. in dilute spirit. Vesuvin—sol. in water. Chrysoidin—sol. in water.	Eosin, Pink—freely sol. in water. Anilin Scarlet—insol. in water; freely so in methylated spirit. Flamingo, deep brownish red—partly sol. in water; freely so in methylated spirit. Ponceau,[1] deep red crimson—partly sol. in water; freely in dilute spirit. Rosanilin—partly sol. in water; freely sol. in dilute spirit. Fuchsin—partly sol. in water; sol. in dilute spirit	Aurin—insol. in water; partly sol. in strong spirit; more so in absolute alcohol. Anilin Orange—ditto, ditto. Tropœolin, in Deep Yellow Glistening Scales—partly sol. in water; more so in meth. spirit. Phosphin, Yellowish Orange—partially sol. in water; more so, but not freely, in spirit. Saffranin—sol. in water and in spirit.	Fluorescin, Greenish Yellow—insol. in water; sol. in spirit, the solution being beautifully fluorescent. Anilin Primrose—only partly sol. in meth. spirit.	Iodine Green, Blue Green—freely sol. in water or spirit Malachite Green, a less Blue Green—freely sol. in water and in spirit.	Soluble Anilin Blue—freely sol. in water. Bleu de Lyon—insol. in water; freely so in strong spirit Methylen Blue, a very Deep Blue—freely sol. in water and in spirit. China Blue—freely sol. in water. Serge Blue—ditto. Blue Black—freely sol. in water.	Hoffman's Violet—freely sol. in water and in dilute spirit. Methyl Violet, the Red predominating—sol. in water partially; freely sol. in spirit. Gentian Violet, the Blue predominating—freely sol. in water. Tyrian Blue, near to Violet—sol. in water. Spiller's Purple soluble in spirit

1 Ponceau is a mixture of rosanilin and phosphin.

A STANDARD SIZE OF BODY TUBE.

AS we wish all microscopists to notice the various sizes of body tubes in the market we shall continue to insert the following table for several more numbers:—

Name of Vendor or Maker.	Description of Model.	Diameter of Ocular.	
		Body.	Neck.
		inches & 64ths	inches & 64ths
Powell & Lealand..	Large Stand.....	1·23½-64	58-64
R. & J. Beck.....	National	1·17-64	57-64
Smith & Beck.....	Large stand.....	1·17-64	56-64
Ross & Co.	Ross-Jackson	1·20-64	57-64
Ditto	Ross-Zentmayer ...	1·20-64	57-64
Dancer.....	Large stand.....	1·17-64	57-64
Browning.....	Ordinary stand	1·17-64	54-64
Swift.....	Challenge	1·13-64	56-64
Collins.....	Harley	1·17-64	
Crouch.....	Premier	1·14-64	54-64
Aylward	Working	1·23-64	56-64
Parkes	Students	1· 7-64	*
Zeiss.....	Ordinary	58-64	*
Leitz	Ditto	59-64	*
Engelbert.....	Ditto	1·6-64	*

Upon those stands marked with an asterisk the camera-lucida is not made to fit in the ordinary way.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

CHOLERA.—A grant of £2,000 has been awarded to M. Pasteur by the French Chambers, to be employed in fitting out a scientific expedition to Egypt to study the cholera. M. Pasteur, it appears, will not accompany the expedition, which will consist of Drs. Roux, Thuillier, Strauz, and Nocard. M. Pasteur, it is almost unneces-

ary to say, expects that cholera will prove to be due to a micros-copic organism. He has written a series of hygienic measures to be observed by the members of the mission, in order to minimise the danger they are about.

AMERICAN SCIENTIFIC EXPLORATION.—The Washington, a vessel of the United States navy, is about to explore the basin of the Mediterranean, examining its depth and temperature, the density and chemical composition of its waters, the geological character of the bottom, the swiftness, general direction, and courses of the currents, and their action on the coasts, and also the fauna and flora of the deeper portions.

HOP VERMIN.—The attack of vermin in the hop plantation seems to be pretty general throughout Kent and Sussex, though, happily, not to the serious extent to which many of the grounds in the Canterbury district have been afflicted. A good deal of alarm has been created by the appearance of lice at this critical period of the season, and many planters have resorted to washing, and the use of the sulphurator. With regard to the twelve acres near Canterbury where the presence of so much vermin was discovered, another inspection not only confirmed the grave character of the former report, but showed that the attack had become even more serious. Thunder showers, followed by hot sunshine, are now needed to keep down the insect pests and ward off blight.

LEITZ OIL-IMMERSION ONE-EIGHTEENTH.—Mr. H. P. Aylward has sent us for inspection two of Leitz high-power oil-immersion objectives, $\frac{1}{15}$th and $\frac{1}{18}$th, they are both of N. A. 1.26. The $\frac{1}{18}$th is virtually a $\frac{1}{20}$th when examined by Cross' formula, and it has the remarkable working distance of .01 inch, working easily over every slide in our cabinet. Its price is, we believe, only nine guineas.

FALL OF STONES IN MANCHESTER.—After a severe thunder-storm in Manchester during the middle of June, the pavement in King-street was covered with small stones, supposed by some to be of meteoric origin. Mr. T. P. Barkas, of Newcastle-on-Tyne, has examined them microscopically, and the following is his report:—"The majority of the specimens received appear to have been newly fractured and consist of whin, their specific gravity being between 2.8 and 2.74. Several of the specimens have a glazed and slag-like appearance, and I infer from their structure that they have been subjected to great heat. It is improbable that newly-fractured stones having the structure of whin should fall from interstellar space, and the probability is that a whirl-wind at some distance from where the stone fell lifted and carried them over the localities where they descended."

GINGER BEER PLANT.—In reply to a query in the *Exchange Mart and Bazaar*, a correspondent sends the following:—There is such a plant in existence. It is not necessary that a plant should consist of root, stem, and leaves, for the ginger beer plant does not possess any one of these organs, it is entirely cellular. The brewers' yeast is admitted by botanists to be a plant, but the ginger beer plant is of a higher organisation than that. It is difficult to say if it is an alga or a fungus. (I can find no mention of it in any botanical text book.) Like the algæ it grows in water, and it resembles the fungi by the absence of chlorophyll; in appearance it resembles soaked rice. The plant must be put in a bottle filled with water to about the narrow part, together with a small quantity of sugar, on which the plant feeds. The quantity of sugar depends on the quantity of the plants and the size of the bottle; a little ginger must also be added for flavouring. The plant obtains its carbon from the dissolved sugar, and also a portion of its oxygen; oxygen may also be taken from the water. By the taking up of oxygen, organic matter is oxidised, and carbonic acid is given off, which is the exhilarating portion of ginger beer. Should your correspondent require a small quantity of the plant (for my stock is very limited), I shall be pleased to supply it, together with instructions for its growth and management.—BOTANIST. [We hope to be able to give a description of this plant in our next number.—ED.]

COLE'S STUDIES.—The first volume of this work gave abundant satisfaction to all subscribers, but judging from the opinions we have received this can scarcely be the case with Volume II.

Mr. Cole has explained how this has come about, in a circular issued to his subscribers, and after stating that he has had to make "fresh arrangements" in order to secure justice to them, he gives notice that "the next number of the *Methods of Research* will be published on *October 20th*, and the next number of the *Popular* Section on *Oct. 27th*, with slide and plate, and thereafter, *monthly*, each Section will be issued with the same regularity which was observed in the publication of Vol. I.; the list of subjects and preparations, as detailed in the prospectus, being strictly adhered to, and Volume II. may be expected to prove, in all respects, an advance upon its predecessor; but, in order to secure this desirable result, and under the circumstances I have explained to you, and in the interests of the subscribers, I have, most unwillingly, after mature deliberation and taking advice, come to the conclusion that the postponement of the publication of the next Number in each Section is an absolute necessity."

We wish Mr. Cole every success in his efforts to provide for a continuance of the good work, such as Vol. I. proved itself to be.

MANCHESTER MICROSCOPICAL SOCIETY. — The Manchester Microscopical Society had an excursion of more than usual interest on Saturday, Aug. 4th, in company with the Ashton-under-Lyne Biological Society, the Oldham Microscopical Society, and the Stalybridge Microscopical Society, the rendezvous being Marsden in Yorkshire. The members of the four societies left the railway station under the leadership of Mr. J. B. Robinson, F.R.M.S., of Mossley, and proceeded to the other side of the valley along the old road over Standedge, and turned sharply to the left up a narrow lane which leads to Wessenden Clough. This clough is of considerable extent, the upper portion being a gathering ground for two reservoirs belonging to the Huddersfield Corporation, which are situated between two and three miles up the valley. Wessenden is becoming a favourite resort for botanists, and rarely have the fields been more varied than on this occasion. A large variety of mosses, liver-worts, grasses, sedges, ferns, and flowering plants were collected by the members. The ivy-leaved bell-flower (*Campanula hederacea*) was the prize each was desirous of obtaining, and several gentlemen were successful in finding it. After the afternoon's botanizing the party returned to Marsden, where, after tea, Mr. W. Stanley, F.R.M.S., was called to the chair. It gave him the utmost pleasure to meet friends from Ashton, Oldham, and Stalybridge belonging to societies like the Manchester Microscopical Society, formed for the study of natural history in general and the use of the microscope in particular. It is not often that four flourishing societies meet upon the same day, at the same place, and for the same purpose; but he hoped that in future a similar meeting would be arranged every year, which, besides extending our knowledge of natural objects, would promote a good feeling amongst the societies taking part in the excursion. Referring to the work that was being done by the mounting section of the Manchester Microscopical Society, he invited members of the other societies present, who took an interest in mounting objects for the microscope, to favour the society with their company at the open meeting for practical demonstration in October, further particulars of which would be sent to the secretaries of each society. Mr. Charles Walters, the energetic secretary of the Oldham Microscopical Society and Field Club, gave an interesting description of the various grasses, sedges, ferns, and flowering plants gathered during the ramble. The inconvenient arrangement of trains on the Manchester and Leeds line caused the party to disperse much earlier than was desirable; but some of the party, determined to make the most of a fine evening, walked over Standege to Diggle in time for the last train south.

SENDING SPECIMENS BY POST.—Some time ago a correspondent

of the "Bazaar" suggested the establishment of a naming department for plants, &c. The idea did not seem to meet with much favour, but the following remarks made by two subsequent writers may give a hint to some of "our" readers:—"I have, as recorder of the Botanical Record Club, had many thousands of dried plants passing through my hands for name, or verification of name, during the last ten years, and although, of course, it is difficult, and sometimes *impossible, to name plants which reach me in a state of pulp*, yet I can assure "Jack of all Trades" that fresh flowers or plants not in flower, only in bud, and mosses, if gathered and sent fresh inclosed in a mustard tin or a starch box, or even wrapped in a little oiled silk or gutta percha tissue, can be named, and safely named, in nineteen cases out of twenty, by any one really familiar with the living things.

* * * *

"The difficulty of transmitting botanical and other specimens by post without injury, to which Mr. May refers in your issue of the 27th July, may be got over by using any of the special postal boxes that can now be purchased at most stationers. Those made by the Folding Box Co. are very convenient, as they can be had any size, at a very low price, and are particularly convenient for botanical and entomological collectors, as a considerable number can easily be carried in the field, and fragile or important specimens placed in them without delay."

MR. BOLTON'S STUDIO.—Thomas Bolton begs leave to call the attention of his correspondents to the display he is making at his stand in the Fisheries Exhibition, just above the Aquarium, close to the Queensgate upper exit, and below the stairs leading to the Western Gallery.

He has had three successive Nests of Sticklebacks brought from Birmingham, and in each case the Male Stickleback has hatched out in due time a brood of young fry.

He has now an attractive display in his microscopes, and last week exhibited a Wheel Animalcule sent to him from Salisbury, which proves new to science, never having been described before.

He has now on exhibition the very rare tree-like Infusorium *Zoothamnium arbuscula*, the beautiful grouped Wheel animalcule *Lacinularia socialis*, and the fresh-water Polyzoa *Cristatella mucedo.*

The circulation of blood in the gill of the tadpole of the Newt, and the circulation of the sap in the water, weed *Nitella translucens*, always proves attractive.

As opportunity occurs, Mr. Bolton has shown various examples of the Parasites of Fish Salmon disease, and many examples of living Fresh-water and Marine Life.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 34. *OCTOBER.* 1883.

HYDRA: ITS ANATOMY AND DEVELOPMENT.

By J. W. Dunkerley.

(Continued from page 245.)

THE ordinary mode of reproduction is by gemmation. When a Hydra is receiving more nourishment than it needs, it increases by a system of buds. That is, diverticula are developed, and what at first are merely blind or hollow sacs, gradually elongate and become pear-shaped. At the free end, and around the outer edge, minute processes are developed, and grow into tentacles, in the centre of which a mouth appears. The bud, which is now a perfect Hydra, sooner or later breaks away. If the parent is well nourished the bud will not only all the longer remain attached to it, but will itself begin to bud; and several children and grandchildren may be seen at the same time upon the parent. But if the supply of food be withheld, and no tentacles have formed, the buds will decrease and finally disappear. But if tentacles have been formed, however small, the buds will break away and live.

At certain seasons of the year reproduction also takes place by the formation of spermatozoa and ova. The spermatozoa are formed within the spermatic capsules. These arise as minute conical tubercles a little beneath the base of the tentacles and form the testes. Fig. 62. They vary in number from three to eight. The spermatozoa were first made out by Mr. Gulliver, F.R.S. The length of each spermatozoon is about $\frac{1}{6400}$ of an inch, and are bodies consisting of a very small oval head, to which a very delicate filament is attached. They may frequently be seen in motion when ripe within the unruptured testis, and can be made out by a one-inch objective. They are liberated by the bursting of the sac. When free, the spermatozoa swim freely in the water, by means of their filaments, and eventually reaching the ovum, fertilizes it. The ovary is formed in the substance of

the lower part of the body. As soon as it begins to be formed there is an increase of the coloured bodies at the corresponding point in the endoderm, and can be seen by the naked eye. The ovum in its first formation consists of ectoderm cells, with a very large number of the smaller forms. In a few hours there may be seen embedded among these cells (one which has become larger and clearer than the rest, and possesses a distinct spot in the centre, which, when fully developed, forms the

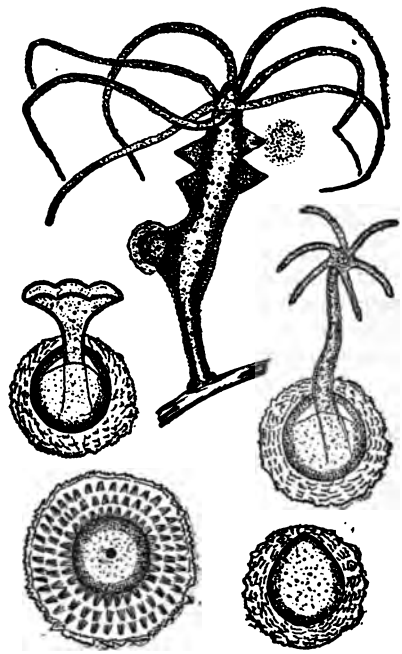

Fig. 65 Fig. 66.
Fig. 63. Fig. 62. Fig. 64.

ripe ovum. The ovum then consists of a clear transparent mass of protoplasm (*vitellus*) in which is also a clear space (the *germinal vesicle*) containing another body (the *germinal spot*). I have had several eggs from *H. vulgaris* and *H. viridis*, but they differ in various respects. That of *H. vulgaris* is larger and rougher on its outer surface (fig. 63), and is covered with short spines. On the outer envelope dark triangular shaped spots can be seen. The ovum of *H. viridis* is covered with an irregular network. The outer envelope is not transparent, and it disappears before hatch-

ing. The diameter of the egg of *H. vulgaris* is one-fiftieth of an inch; that of *H. viridis* one-sixty-sixth of an inch. When the ovum is expelled from the ovary it is very transparent and soft, and remains attached to the body of the Hydra for some days. It is then that the spermatozoa escapes from the testis and fertilize the ovum. The egg is at first a cream colour, but changes to orange colour. When detached from the Hydra the egg sinks to the bottom of the water, and soon becomes covered with extraneous matter, through which it cannot be seen, and by which it is protected from pressure until it hardens.

As a rule, after the extrusion of the ovum, the Hydra slowly dissolves and disappears. But I have had exceptions, when the Hydra has only partly dissolved after producing the ovum. In one case in which *H. vulgaris* had been divided in February of this year, it healed up again, and in March produced ovum and spermatozoa. After expelling and fertilizing the ovum, it turned itself inside out until the tentacles could not be seen, and then expelled a second egg and fertilized it. After this performance the head dissolved, but the lower part of the body lived and budded, after which performance it formed a new head. This is, undoubtedly, a rare occurrence.

As a rule *H. viridis* produces the ovum in the spring, *H. fusca* in the summer, and *H. vulgaris* in the autumn, but the above order is not always maintained, for I have seen the ovum of *H. vulgaris* in the latter part of the winter, and you will see this evening *H. viridis* producing the sperm ducts, and, in all probability, the ovary and the ovum.

The eggs are supposed to be hatched in the following spring; but I find that in confinement this is not the case, and that they are all hatched in a few weeks. As the time for hatching approaches, the envelope becomes thinner at one part, in consequence of the egg being pushed out at that side (fig. 64). This I observed on April 26th, and it was forty-nine days after expulsion. One hour after this appearance, a small opening was seen in the shell, the egg appeared to alternately contract and expand until, at last, the tentacles of the young Hydra appeared, as shown in fig. 65, three hours after the crack was first seen. For a few hours this young Hydra continued to develope, although but slowly. In 16 hours it was perfectly formed, although very minute. It had six tentacles, and when fully extended appeared as in fig. 66. It remained attached to the shell for three days, continually contracting and expanding. In appearance it was very transparent and snowy white. After leaving the egg, the growth of the young Hydra is slow. It appears to take no food for some weeks.

The number of the tentacles vary from three to seven. I have in some cases observed the young Hydra bud before they partook

of any food, after which they grow and bud freely according to the food given. I have been in the habit of feeding them daily, thus preventing their destroying more than they could eat. My experience in dividing the Hydra has been to me exceedingly interesting. Three years ago I determined to test, by practical experiment, the truth of what had been written as to the wonderful healing powers of this polype. For some time I had no success, although I carefully cut my sections, but had the mortification to see them simply slough away. Further experiments revealed the cause of failure. Changing the water either before or after the division is fatal to success. Weak or sickly Hydra will die in a few hours after division if the weather is cold. But if a well-fed and vigorous Hydra be cut into sections, and the parts are placed back into the same water either in a watch glass or a small bottle (I prefer the latter) and the room is not allowed to get cooler than about seventy degrees, each section might become a perfect Hydra. I say "might" advisedly, for I find the division of Hydra a very difficult operation, and one that requires great care and patience; and with all the care and patience, that eighty per cent. will die. May and June as the best months for reproducing the lost parts. At that time Hydra are the most vigorous, and bud freely; in fact, I prefer to divide those which have very young buds. Placing them upon a fine cardboard in a drop of water, I cut them with a fine scalpel into slips as you would a plant, or I simply cut through a part only of the polype. The cut parts take from three to fourteen days, and even more, to become perfect,—that is, before they reproduce their lost parts,—or they may live for a few days and then disintegrate. The production of a perfect Hydra from a single tentacle requires the longest time; to reproduce a new head from the foot part requires a shorter time; and that which perfects itself the quickest is the head, which in a few days will have acquired a small body with fully grown tentacles.

The following dissections I have successfully repeated several times. First—cut off head of Hydra. Second—cut head into seven sections, each section having one tentacle. Third—cut through head and stomach, but not through the foot. Fourth—cut through foot and stomach, but not through the head. Fifth—cut off single tentacles, no part of the body being attached. Sixth—cut the body lengthwise into two distinct parts. Seventh—cut off the suctorial disc. This took about the same length of time as the tentacle to become perfect. Besides these experiments, I have also divided Hydra in various other ways.

One of the most curious and difficult experiments upon the Hydra is to turn one inside out. This is a feat the animal will sometimes perform of its own accord. Placing a Hydra in a drop of water upon a cardboard, I forced a fine instrument through the

mouth and body cavity, passing it at the same time through the suctorial disc. Then withdrawing the point out of the cardboard, I carefully pressed the head downwards with a blunt instrument. It then turned upon itself, and when I withdrew the needle it was really inside out.

Professors Huxley and Martin state there is reason to believe that the Hydra reproduces itself by self-division. I have discovered this to be a fact, by seeing the Hydra self-divide on several occasions. The process was as follows :—Attaching itself to the sides of the glass, it extended its body and tentacles to an extraordinary length, and then seizing a water plant with its tentacles, it began to contract at both the anterior and posterior ends, whereby the centre was drawn out to a very delicate thread, when by a long pull, a strong pull, and a pull all together, the separation was effected. In due time the head acquired a new foot, and the other part a new head. Natural division only takes place during the warm weather. It thus appears to me that in dividing Hydra we simply imitate nature.

SPONTANEOUS FISSION IN AN AQUATIC WORM.

By W. Blackburn, F.R.M.S.

Read before the Manchester Microscopical Society on 6th September.

THE order *Oligochæta* comprises those worms that move partly by means of stiff bristles projecting from the soft integument. These bristles are placed in rows on the lateral and ventral aspects of the body, the dorsal surface being free from them. There are no tentacles or branchial processes. Within the integument are two layers of muscles, an external circular, and an internal longitudinal layer. These structures enclose a cavity, called the *perivisceral space*, which is filled with a corpusculated fluid. Floating in this fluid is the alimentary canal, which carries on its upper surface the dorsal vessel, containing a reddish non-corpusculated fluid, which it propels forward towards the head. This coloured fluid then passes through a plexus of small vessels, which again unite to form the ventral vessel, through which the fluid passes backwards towards the tail. The ventral vessel is attached to the lower surface of the alimentary canal. Another plexus of small vessels completes the circuit, and restores the fluid to the dorsal vessel. Besides these plexuses, which are cutaneous, a number of large

branches, called *perivisceral*s, communicate between the two main vessels, either with or without the intervention of the cutaneous plexus. Some of the anterior perivisceral branches are much enlarged and pulsate, forcing the blood into the ventral vessel; they are therefore called *hearts*.

It has been a question which of the two fluids (the perivisceral and corpusculated, or the vascular and non-corpusculated) represents the true blood. Dr. Carpenter considers the corpusculated fluid to be the blood, which obtains aëration from the fluid in the vascular system, the branches of which act as internal gills. Dr. T. Williams and Dr. W. C. McIntosh, however, affirm, and it is now generally believed, that the coloured fluid, contained in the vascular system, is the true blood, and the corpusculated perivisceral fluid is chyl-aqueous in its character. Respiration is regarded as being accomplished by means of the cutaneous and intestinal plexuses of the vascular system, which are in contact with the water external to the body, and with that which flows through the alimentary canal.

It is also believed that the perivisceral fluid has a mechanical use as an aid to locomotion. Dr. Thomas Williams, in his Report on British Annelids, published in the British Association Reports for 1851, says:—"In all annelids the swelling of certain portions of the body in progression is accomplished by aid of the fluids of the interior. This is driven to a given point of the containing cavity, and then momentarily imprisoned there by the contraction of the circular integumentary muscles in front of it and behind it. Hereat, for a moment, the body bulges, the muscles of the integument are then excited to action, and the fluid is forcibly compressed forwards and backwards, according to the direction of the muscular agency. . . . . Nearly all annelids are struck with paralysis when this fluid is made to escape from its cavity by a puncture through the external walls. The power of voluntary motion is suspended. The body of the worm becomes passive and flaccid. The peritoneal (perivisceral) fluid is really the fulcrum on which all muscular action is based. Without it, the worm cannot direct the contraction of its muscles with efficiency and precision. But its mechanical uses are not exclusively limited to the aid afforded in progression. It prevents mutual and injurious pressure amid the internal organs, without which the course of the blood in its proper vessels is arrested;" and "on it, as on a pivot, the vermicular motion of the intestinal cylinder is performed."

Internal septa divide the animal into numerous segments, and orifices in the septa allow the perivisceral fluid to pass from one segment to another. The alimentary canal, which passes through the septa, and is slightly constricted thereby at each septum, is of a simple character, consisting only of a pharynx, œsophagus, and

intestine in some of the groups, to which in others a crop and gizzard are added. There are also small tortuous tubes floating in the perivisceral space, with enlarged circular terminations or orifices in nearly all the segments; they are supposed to have an excretory function. It is unnecessary here to notice other anatomical peculiarities, except that, when mature, both sexes are found in the anterior segments of the same individual. The sense of sight is present in some of the group.

The order was divided by Claparède into two families: the *Terricola*, or earth-worms, and the *Limicola*, or mud and water-worms. D'Udekem, however, divided them according to their modes of reproduction, into gemmiparous and non-gemmiparous. The former are water-worms, and are able to swim and pursue their prey; the latter are unable to do so, and inhabit moist earth or mud. A sub-family of the Limicolæ are the Naididæ, or nymph-worms, remarkable for their transparency and the freedom of their motions, but chiefly by their power of reproduction by budding and fission. They are hermaphrodite, but the sexual elements are not developed until they approach maturity. Previous to the attainment of this condition, however, they are said to multiply by self-division.

Charles Bonnet, an eminent Swiss naturalist, who lived in the latter half of the last century, was the first to describe the self-division of worms, and to experiment upon their powers of reproduction. Prof. Owen says that "Bonnet progressively increased the number of sections in healthy individuals of a small worm, *Lumbricus variegatus*, and when one of these had been divided into twenty-six parts, almost all of them reproduced a head and tail, and became so many new and perfect individuals." "Bonnet cut off the head of one of these worms, and as soon as a new head was completed he repeated the act; after the eighth decapitation, the unhappy subject was released by death; the execution took effect, the reproductive virtue had been worn out." Again, "With this power of reproduction of lost extremities, is associated that of spontaneous fission in the genus *Nais*. In this little red-blooded worm the last joint of the body gradually extends and increases to the rest of the animal; its anterior part begins to thicken, and to be marked off by a deeper constriction from the penultimate link. In the *Nais proboscidea* a proboscis shoots out from it, like that on the head, and it is then detached from the old *Nais*. It often shoots out, previous to its separation, another young one from its own lost joint in a similar way, and three generations of Naids may thus be organically connected, and forming one compound individual."

Dr. Thomas Williams thus characterises these statements:—"On the authority of hundreds of observations, laboriously repeated at every season of the year, the author of this report can declare,

with deliberate firmness, that there is not one word of truth in the above statement. It is because accounts so fabulous have been rendered respectable by the fact that Prof. Owen has thrown over them the ægis of his great authority, that they demand a contradiction, which may displease by the strength of the language in which it is given."

Dr. Williams sums up the life-cycles of these worms thus:—"These annelids are annuals; the term of existence is completed when the organic cycle is once accomplished. They are born during the latter months of one summer, and survive the winter, attain to maturity of growth, reproduce the species, and die by the spontaneous subdivision of the body into fragments, on the arrival of the same season of the succeeding year. . . . . For some time before fission of the body occurs, the process of maturation of the ova is proceeding. Arrived at the mature phase, they escape into the free space of the peritoneal cavity, wherein they sojourn until the next phase of their growth has been attained. It is during the period marked by the presence of true ova in the chamber of the peritoneum, floating in the contained fluid, that the division of the body of the parent animal takes place. In each fragment is nestled, incubated, a considerable number of ova. Filled still by the fluid of the peritoneal cavity, each fragment becomes subservient to the end of hatching the young. It resists decomposition only for the period required for the accomplishment of this purpose. When the ova are committed to the sand, the fragment rapidly disappears by putrefaction. The fission of the body, thus interpreted, becomes the last act of the parental worm, since the portions into which the body is subdivided by fission never take food." . . . . "With the fission the necessity for food terminates. If, on the contrary, the division of the body were the first step of a real reproductive operation, characterised by the superaddition of new fragments of the body, the reconstruction of lost heads and the manufacture anew of departed tails, a resort to physiological argument were little required to prove that each fragment should grow voracious, and consume extra supplies of nourishment, in order to provide the necessary pabulum for the reparation of the mutilated parts." He also states that artificial sections of these worms do not immediately kill them. The two parts of a divided worm writhe in involuntary motion for a few days, when mortification attacks the wounded segments, and gradually extends to the head in the one half and the tail in the other.

Against this statement I will place the following by Dr. McIntosh:—"Besides the ordinary development by ova, it has long been known that *Nais* and *Chætogaster* exhibit fissiparous reproduction. In *Nais*, after a certain degree of growth has been reached, budding takes place, so that several tolerably complete

young forms may be found attached to the adult. The process goes on until the *Nais* has been reduced to twelve or fourteen rings; then a pause occurs, and the animal increases in length to forty or fifty rings, when a new cycle commences by division in the middle of the body. Reproduction of lost parts readily takes place in this group."

These are quotations from two of our greatest authorities on the Annelida, so that their variance is remarkable.

Mr. A. Hammond, F.L.S., the president of the Postal Microscopical Society, in an article in the Journal of the Society for 1882, calls attention to the views of Dr. Williams, and describes an act of fission in a Naid worm, *Stylaria paludosa*, as witnessed by himself and Mr. Baily. I may remark that the *Stylaria paludosa* of Lamarck is the same species as *Nais proboscidea* of Linnæus. Oersted places it in his second division of Naids, which includes those that have "segmenta quatnox anteriora (interdum sola duo)

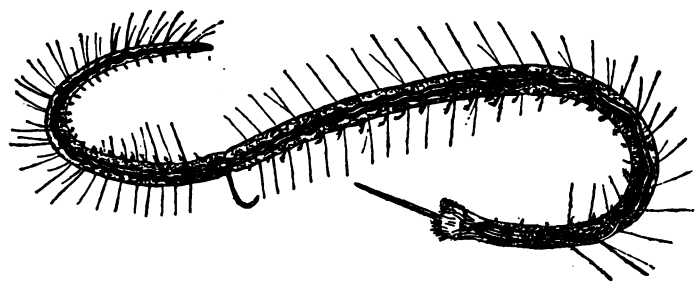

Fig. 67.

setis superioribus destituta." Mr. Hammond describes a constriction taking place amidst some new segments which had been formed towards the lower third of the body, and below the constriction a new proboscis and eye-spots, the separation of the worm into two parts, and the formation of a new head on the tail half. He does not, however, tell us whether the worm was mature or immature, whether there were any ova in the perivisceral space, whether a tail was formed on the head half, how long the two individuals lived, and whether either of them took food after separation. Nor shall I be able to enlighten you upon some of these points; but as far as my observation goes I will record it.

One day last summer I found a specimen of *Stylaria*, three-eighths of an inch in length, with the bristles absent from some of the segments of the lower half of the body. Upon examining it with the compound microscope, I found the constriction and new proboscis described by Mr. Hammond.

This proboscis moved about in incipient appreciation of the external world, and in hereditary imitation of its counter-part on the parental head. There were two eye-spots visible. The intestine was continuous through the constriction, and performed uninterrupted peristaltic motions. The glandular cells, which give the intestine a dotted appearance, were absent from the hairless segments. The short-hooked hairs, which are usually found, four together, in two rows on the ventral surface were present on all the segments except the heads. The dorsal vessel was uninterrupted at the constriction, and its rhythmical contractions were performed in the usual manner.

Twenty-four hours elapsed before I continued the observation, when I found that the two parts had separated. The last segment of the head half had a blunt extremity, and the new head of the tail half looked exactly like that of its parent, but smaller. The motions of the two were of a voluntary character, progressive, and as if in search of food. I did not, however, see them eat. There were no ova in the perivisceral space, and the parent worm was evidently immature, as it possessed no ovary. A subsequent observation showed the new head to be enlarged nearly to the size of that of its parent, and the blunt extremity of the parent to have assumed a more tapering form, the glandular cells of the intestine having extended downwards.

I was unable to continue the observations any further at that time, and have not met with any more worms in a state of fission; but in the hope that others may pursue the investigation, I offer this small contribution to the history of the reproduction of an interesting aquatic worm.

THE GINGER BEER PLANT.

By George E. Davis.

A paper read before the Manchester Microscopical Society, September 6, 1883.

SOME few weeks ago there appeared in the literary columns of the *Exchange Mart and Bazaar* an account of a Ginger Beer Plant, which was described as a fungus very similar to boiled rice in appearance, and capable of inducing fermentation in a solution of sugar.

Before I go further it will be as well to point out that there are two distinct varieties of "ginger beer,"—the one produced by a fermentative process from sugar and water, and flavoured with ginger and other condiments; the other a saccharine solution,

rendered palatable with various essences, and impregnated with carbonic acid gas by means of machinery. The former is generally called in Lancashire "stone-pop," while the latter is produced by the manufacturer of aerated waters.

It was with some degree of surprise that I heard of a specific ginger-beer plant, having always been under the impression that the substance inducing the fermentative change was ordinary yeast or barm, but on making inquiries into the matter I found the same "plant" in many localities producing a beverage drunk in the summer as ginger-beer.

The *modus operandi* appears to be as follows:—A solution of sugar and water is placed in a large mug or jar, standing in a warm corner of the kitchen; the ginger-beer plant is added, gently stirred, and fermentation allowed to go on without any more attention. In a few days a large quantity of free carbonic acid is found in solution, and very small quantities of alcohol also; the "plant" remaining at the bottom, and the liquor above it being remarkably clear. This liquid is baled off for use, and when the quantity is getting low, the jar is filled up again with a solution of sugar and water, to undergo the same process as before. It is not quite clear to me yet how the increase of the plant is brought about in a solution of refined sugar; but it has been increasing with me, although fed with a pure sugar. One can scarcely believe that this multiplication can go on indefinitely without fresh increment of nitrogenous matter, phosphate. Query,—is the absorption of atmospheric ammonia by the liquid, sufficient for this?

We now come to the most important part of the paper: What is the ginger-beer plant? All of you have doubtless heard of, and many may have seen, the yeast plant, which induces the alcoholic fermentation in sugar. It should be known that there are two distinct varieties of commercial yeast: ordinary yeast, or that which collects on the surface of beer in the usual method of brewing, and sedimentary yeast, which falls to the bottom of the fermenting vessel during the brewing of Läger beer. The first is active at temperatures varying from 15° to 20° C., while sedimentary yeast is active at temperatures from 6° to 8° C. I suppose we may take it for granted that the first batch of yeast formed in the world as a commercial operation, must have arisen spontaneously, and that some process of differentiation has arisen, tending to separate the ordinary from the sedimentary. The differences between these two forms will be seen from fig. 68, the surface yeast on the right, the sedimentary on the left.

A glance at our ginger-beer plant will soon show us that it has but little in common with the ordinary or surface yeast. The fermenting solution is quite clear, even to the very top, and the appearance of the plant, taken by itself, is far different to that of

brewer's yeast or barm. The yeast plant, formerly called *Torula cerevisiæ*, and still later classified under the generic term Saccharomyces, has been the occasion of much discussion. Berkeley, in his Introduction to Cryptogamic Botany, says on page 242, "It

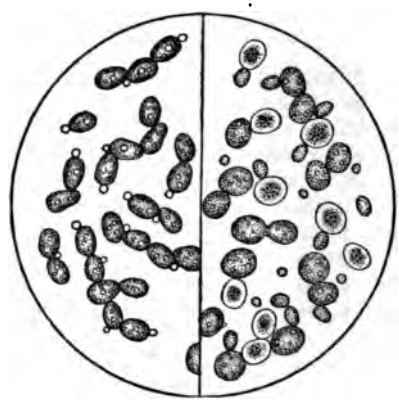

Fig. 68.

has been proved by myself and Mr. Hoffman, by following up the development of individual yeast cells, in fluid, surrounded in a closed cell with a ring of air, that the proper fruit is that of a Penicillium." Pasteur, the celebrated observer of these organisms, has made many experiments upon this subject, and he arrives at conclusions at variance with these two former observers. In his splendid work, *Etudes sur lar Bière*, Pasteur gives the details of his experiments, and exhibits the care taken to avoid contamination by extraneous germs, and he seems to have conclusively proved that ordinary beer-yeast has no connection with any species of fungus of the genera Penicillium, Aspergillus, or Mucor.

Many of the mould-fungi will grow sub-aqueously, their mycelioid filaments having in my hands often yielded the perfect aerial fructification, and it is more than probable that commercial yeast always contains adventitious spores of the widely spread Mucedines, Mucorini, and Dematiei, so it is not very surprising that Penicillium has been cultivated from some of its particles.

Members of the genera Penicillium, Aspergillus, and Mucor, under certain conditions, have been found to produce small quantities of alcohol, and their sub-aqueous multiplication during the process is very peculiar. M. Pasteur has thoroughly investigated this subject, and what he has to say regarding the Mucor ferment may help us to distinguish the true character of our ginger-beer plant.

So early as 1857, M. Bail announced that the fungus, *Mucor mucedo*, was able to transform sugar into alcohol by fermentation; which assertion was correct, though he fell into error, according to Pasteur, in stating that it was metamorphosed during the process into ordinary yeast. Pasteur states, "these two plants should be profoundly distinct, and if divers authors have obtained them mixed one with the other in the culture of Mucor, it is no doubt because they were adventitiously sown with the beer yeast, the germs being abundant, particularly in the dust of the atmosphere of all laboratories where studies relative to fermentation are made."

The sub-aqueous growths of Mucorini are very interesting and instructive, showing, as they do, their adaptability to various and very diverse circumstances. With the ordinary aerial form every observer of these organisms is familiar: the long erect hyphæ, bearing spherical capsules at their summit, filled with variously-shaped spores which easily germinate, their development being readily studied. The sub-aqueous growths are but little known, and it will be well here to borrow from Pasteur's researches, which may be found in detail in his *Etudes sur la Bière*.

Mentioning the Mucor ferment, he writes :—"After an active life in contact with the air, or even with a limited quantity thereof, it

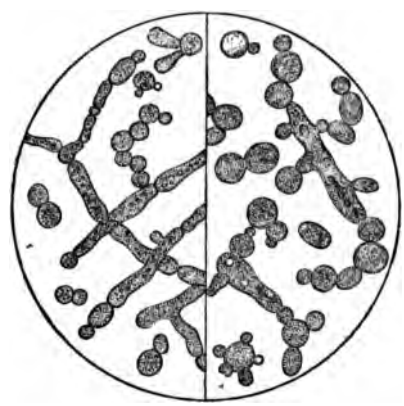

Fig. 69.

can still live out of the direct action of this element. But when deprived of oxygen there are apparently seen all the signs of alcoholic fermentation, that is to say, a notable proportion of sugar, relative to the weight of solid matter assimilated and fixed by the plant, decomposed into alcohol and carbonic acid gas, a decomposition which continues so long as active life remains in the submerged cells. Fermentation ceases absolutely, or continues in such a sub-

dued fashion as to be insensible, when all vital activity disappears in the cells, and they appear old, used up, and of deformed contour, becoming full of granulation; but if life is suspended it is not extinct, it is only an apparent death. If oxygen is allowed free access and the plant allowed to live for a while exposed to its action, it takes a new lease of life and is able to start anew the fermentation of sugar."

This statement is very important, and to aid us in our opinions regarding the ginger-beer plant, I will show you a drawing of Pasteur's Mucor ferment (fig. 69), the right half representing the plant deeply submerged, while the left half corresponds to the vegetation but little submerged, and consequently having at its disposal a certain quantity of air, which, though insufficient for its ordinary growth, is still enough to prevent the plant from becoming quickly exhausted.

Let us now see what appearance the ginger-beer plant presents

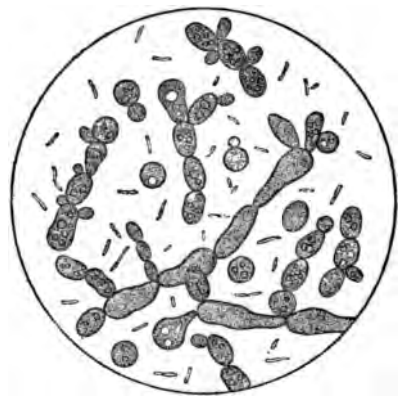

Fig. 70.

under the microscope. When viewed with low powers, very little can be seen,—a $\frac{4}{10}$ and the B eye-piece being the lowest power under which anything can be seen. With a $\frac{1}{4}$th or $\frac{1}{6}$th a very fair view of the substance can be obtained, but still it is very difficult to make out details, and it is only when we come to use the $\frac{1}{8}$th that a satisfactory view of the plant can be obtained. The best view undoubtedly is by use of the $\frac{1}{12}$th, $\frac{1}{14}$th, or $\frac{1}{18}$th objectives, and in these observations I have chiefly used Leitz oil immersion $\frac{1}{18}$th which is easy to use, as there is plenty of light and quite enough working distance for all ordinary purposes.

You will see (fig. 70) there is but little doubt that the bulk of the so-called ginger-beer plant is made up of the Mucor ferment,

and the mode of its use conduces singularly enough to its constant action. When the plant is well-covered with liquor, it grows more, as indicated in the diagram, but when nearly all the ginger-beer has been baled out, the air has free access, and rejuvenescence is again effected.

You will notice that the spores occur in masses, not unlike the description given, as boiled rice; this is owing to the matting together of the mycelioid filaments, as you may see by working at it with the microscope.

I say there is but little doubt that the *bulk* of this plant is composed of the Mucor ferment, but it is by no means wholly composed of it; there are many cells of ordinary sedimentary yeast to be found in the field, mixed also with filaments, due, no doubt, to Penicillium and Aspergillus, and there will be found others of a more minute description, such as we are apt to classify, when seen, under the general term bacteria. Two of the samples I will show you under the microscope have been stained with Bismarck brown in order to show these bacteria more plainly. To show you a yeast which appears spontaneously, and which is capable of exciting fermentation in sugar solutions, I have a slide of fungus from sugar-house liquor; it is one of the ferments produced by the sub-aqueous vegetation of some of the mould fungi; there are to be seen the long filaments and the cells increasing by budding just as in the ginger-beer plant.

To sum up—the ginger-beer plant is a very impure yeast or leaven, of a different character to ordinary brewer's yeast or German barm. It consists of many varieties of cells, oval, round, and some extremely elongated; the whole are bound together by mycelioid filaments which increase as the air has free acces to it. The smaller or bacteroid cell I have not had sufficient time to work out, but my impression is that they induce the peculiar flavour found in the liquid. Certain it is that by cultivation this can be considerably reduced in quantity, and the flavour then alters very materially.

I have not had sufficient leisure to give the aerial form of this fungi, but this may form another communication to you at some future date.

WATER, WATER ANALYSIS, AND THE MICROSCOPE.

DURING the prevalence of Cholera in Egypt, public attention was often called to our water supply; every one was on the alert to discover something abnormal in drinking water, and it would have been strange indeed had nothing been observed in the

liquid drawn from service pipes or cisterns. The atmosphere being now more calm, and the cholera scare over, at least for this year, the subject can be considered more deliberately than on the eve of a panic, when reason for the most part disappears, and hasty modes of action become the orders of the day.

The germ theory of zymotic diseases indicates that these diseases are propagated by means of living spores which increase and multiply upon finding a suitable nidus, and it has by many been considered proven that cholera and typhoid excretions entering a source from which drinking water is drawn will induce these specific diseases in persons drinking such contaminated water.

Other diseases may possibly be of similar origin to those we have indicated above, but as it is not our intention to discuss the question from any other but a general standpoint, we must be contented with pointing out some of the peculiarities of many of the statements generally placed before readers of these subjects.

Chemical analysis is *per se* an operation entirely inadequate to give a trustworthy indication of the quality of a water for drinking purposes: it may be able to give the relative quantities of some of those substances found also in human ejectamenta, but it is unable to decide positively that the said substances have had this origin. It must also be said that chemists, as a body, are not agreed upon what is the best system of chemical analysis, and even when results have been obtained by any one of them, it is by no means certain that the interpretations given are correct.

A notable instance of this may be found in the *Journal of the Society of Chemical Industry*. In a paper read by Mr. J. Carter Bell before the *Manchester Section*, he stated that "a gentleman connected with one of the large orphan asylums near London showed me five different analyses of the same water received from five independent analytical chemists. The analyses and the decisions arising from them were so different that the directors knew not what to do. The facts of the case are these: The governors of the institution had sunk a well between three and four hundred feet deep. When finished the water was analysed, and chemist A said it was very good. After a little time it was analysed by a firm of analytical chemists, who condemned the water, saying that it was surface water, and that it was not suitable for drinking, as at certain seasons of the year, owing to the fields being dressed with manure, it would become far more impure. They strongly advised the directors to obtain their drinking water from another source. This report of B was not pleasant for the directors to receive, and, having several hundred children to care for, they were bound to pursue the matter further. They then called in chemist C. He said that the water contained so much organic matter that it was perfectly unfit for drinking. The

directors knew that they had taken every care in sinking the well, and also that no sewage matter could possibly come near it. They felt convinced that the water was not so bad as B and C had reported it. Nothing daunted, and thinking that in the multitude of counsellors there is wisdom, they called in the aid of chemist D. He considered the water quite fit for all domestic purposes. D also wrote a letter, saying that, as far as chemical analysis could determine, the water from the well was fit to drink, and that it was not necessary either to boil or filter it previously to use. Chemist C had previously said that none of this water should be used without filtering. From this report the directors gained courage. Still they were between two opinions, and to settle the question a sample of the water was sent to E. The report was: 'The quantities of free and albumenoid ammonia contained in this water are very small, and in this respect the water may be pronounced to be very pure.' A letter was also sent, with this remark in it: 'I am glad that the results are so favourable. The waters are, indeed, unusually pure, but somewhat too hard.'"

These instances could be multiplied to an almost unlimited extent were it necessary to do so, but quite enough has been said to show that even from the same samples chemical reports may differ, and that the reports of most chemists upon the subject of drinking water are not, as a rule, trustworthy.

In the August number of *The Nineteenth Century* there is a paper on "Cholera and Water Supply," by Dr. Percy Frankland, in which the words "chemical analysis" so frequently recur as to give the uninitiated the idea that the results of the processes admit of easy, definite, and decisive interpretation: this is not so, the balance of evidence being directly contrary to any such proposition. We venture to say that if a gallon of the purest water were mixed with 50 grains of salt and a few drops of the white of an egg, and sent to a chemist for analysis, he would, most probably, certify the water as dangerous to drink, and state that it contained so-and-so many grains of sewage matter. Again, if a few grains of either of the nitrates of sodium or potassium be added to a gallon of water, and dealt with as above, the chemist would probably regard their presence as indicative of "previous sewage contamination," and record his opinion in the usual way.

Perhaps the most important paragraph in the article before us is the following:—

"The subject of domestic filtration is one which, in a town with a water-supply like that of London, possesses peculiar interest, and is of no little importance. Most people imagine that by once going to the expense of a filter they have secured for themselves a safeguard which will endure throughout all time without further trouble. No mistake could be greater, for without preserving

constant watchfulness, and bestowing great care upon domestic filtration, it is probable that the process will not only entirely fail to purify the water, but will actually render it more impure than before. For the accumulation of putrescent organic matter upon and within the filtering material furnishes a favourable nest for the development of minute worms and other disgusting organisms, which not unfrequently pervade the filtered water; whilst the proportion of organic matter in the effluent water is often considerably greater than that present before filtration."

The carbon blocks in ordinary use should be frequently renewed, but as in many forms of filter this is inconvenient and expensive, we have pleasure in bringing Maignen's "Filter Rapide" to the notice of our readers. This filter consists of a stoneware case and a filtering frame of the same material. The frame is covered with a special filtering cloth, and the filtering medium is automatically deposited on the cloth by being mixed with the first liquid put into the filter. It is this layer of filtering medium which produces perfect filtration. Various kinds of filtering medium, such as powdered charcoal, or magnesia, or paper pulp, may be used, and in some cases the sediment in the liquid to be filtered is sufficient to act as a filtering medium.

These filters are very useful for trying experiments in the laboratory. They are fitted with the canvas cloth, which is suitable for filtering most liquids, but woollen and asbestos cloths may also be had for strong acids or strong alkalies.

This filtration of water will not remove the dissolved impurities, but all the animal and vegetable debris will be left behind, together with such living organisms as may exist.

In the paper by Dr. Percy Frankland, already quoted, the following paragraphs appear to us to require modification, if not absolute contradiction; this must be left till our next number, except the last sentence, which we think very generally states the case of nearly all water supplies in this country. Dr. Frankland writes:—

"The doctrine known as the self-purification of river water is one of the most remarkable of the theories which have been started to soothe the conscience of the river-polluter on the one hand, and of the purveyor of polluted river-water on the other.

"As its name implies, this doctrine alleges that noxious organic matters discharged into running water are rapidly destroyed in the course of a few miles' flow. A doctrine more utterly dogmatic than this it is difficult to conceive, inasmuch as it not only does violence to all previous knowledge concerning the properties of organic substances in general, but is unsupported by any facts or observations. On the contrary, the late Rivers Pollution Commissioners conclusively proved that water once polluted by sewage

is but very slowly purified, either by violent agitation on a small scale in the laboratory, or by the aëration to which it is subjected in passing over weirs and falls in a river-bed. Again, recent research clearly shows the extreme tenacity of life which is possessed by the low organisms or bacteria which are supposed to be allied to those capable of communicating zymotic disease, a tenacity which will certainly not yield to the hardships of a few hours' bath in river-water.

"Moreover, that the Thames water reaches the intakes of the water companies with a but slightly diminished quantity of organic matter, is unanswerably attested by chemical analysis.

"Owing to the official surveillance which for some years past has been kept over the metropolitan water-supply, the appearance of the water as it reaches the consumer is very different from what it is in the river itself at the intakes of the companies. For no company would now venture to supply water which was actually offensive to the eye.

"Of the eighty-four samples of Thames and Lea water that passed through my hands during the past year, nearly all were, as far as eye-judgment is concerned, unimpeachable. But it must not be supposed that this has always been the case. All of us must be able readily to call to mind occasions when the water drawn in London was, in appearance, not so far removed from that of the river-water at Hampton."

August and September of every year, bring with them numerous complaints of the drinking-water supplied by the Corporation of Manchester. Minnows, insects, and other organisms, are often found coming through the taps. This has been denied again and again, but the following letter from the *Manchester City News* seems to place the matter beyond doubt:—

"SIR,—the four enclosed specimens of fish, apparently belonging to the whitebait order, insignificant in size and possibly yet inoffensive, may be deemed interesting as having been captured this (Thursday) morning fresh from the Corporation main hard by the south-east corner of Owens College—taken alive and kicking from the pools left after the filling of a watering cart. I had hastily classed them among the 'stickle-back' or 'Jacksharp' order; but the turncock presiding asserted firmly, and with a touch of pride (after I had declined his offer to collect a large number), that they were 'real, proper fishes'—'and wick enough too!" Among memories of far-off ponds in which our first rude lines were cast, the bold stickle-back, captive in his jar, is a delightful and familiar figure; but the apparition of his lively little body wriggling among the granite setts about a tram line is strange and out of place, and prompts the unpleasant thought that shoals of these wanderers may exist within the mains below, and being overtaken with

disaster and decay, produce the ancient odour often of late arising from the water supplied to this neighbourhood. A proper system at the filtering beds ought to keep the water in the mains free from fishes.

"HENRY F. WARDEN."

In our next issue we shall bring forward some of the chief microscopical characters of waters, and endeavour to place the matter in a fair light before our readers, reserving our third article to the question of the self-purification of river waters and the germ theories of zymotic diseases.

BIRMINGHAM MICROSCOPICAL SOCIETY.

ABSTRACT OF PRESIDENT'S ADDRESS, 1883.

I PURPOSE devoting my address this evening to some account of my own particular pursuit, much of which is applicable, to a large extent, to other branches of study in which the microscope takes an all-important part—viz., the collecting, growing or cultivation, and examination or display of microscopic aquatic life. So much invaluable information upon the first subject is given in numerous works at hand that I feel I shall have to repeat much that has been said before, and give little which can be called strictly original.

I have thought it strange that while marine creatures are sought regardless of cost or peril by means of very elaborate and skilfully-contrived appliances, dredging and sounding apparatus, steamers specially fitted out for cruises in dangerous parts of the ocean, zoological stations and expeditions arranged under the auspices of even a British Government, the living multitudes (fishes excepted) which inhabit our rivers, lakes, and ponds should be left to individual and usually very casual and unsystematic research. It is doubtless attributable to this cause, or neglect, that so many of the forms found in this country come to us rather as proofs of the faithful industry of observers in other countries than of our own original work and enterprise.

It is true that investigations in marine zoology are often associated with other matters of equally great scientific and commercial importance, and that the marvellous fauna of the ocean is vastly more grand and extensive; but, on the other hand, so many of us are destined to live in inland districts, and so keen is our appetite for an insight into the beginnings of life, that the tiny in-

habitants of our ponds and streams should claim a much larger share of our thought than they do, for it is upon them that we have to rely chiefly for our acquaintance with those wondrous works of nature which are the foundation and key to the science of Biology. It sounds oddly enough that an expedition should go out for a few years' explorations in arctic, antarctic, and tropical seas, with every preparation for the capture and study of their faunæ by the first men of science, while our creatures at home should be left to the enthusiastic "Sir Thomas," who ties his bottle to the end of his stick or umbrella, and who may perhaps venture so far as to go over shoe-top in his endeavour to reach some desired spot, or capture some coveted creature. It is not because the knowledge of these creatures is of little importance, for we have oft-repeated evidence that a better acquaintance with the part they play in the economy of nature will be of the utmost value to us in our attempts to understand the principles of health and disease. I have felt ashamed that, with the exception of a few splendid works, such as "Allman on the Fresh-water Polyzoa," "Baird's Entomostraca," and some others, we have to rely chiefly upon foreign publications for descriptions of our own microscopic life. No wonder that so many of us looked forward with delight to the completion of that excellent work by our friend and member, Saville Kent, upon the Infusoria, preceded as it was by that of G. S. Brady, upon the Copepoda, and another noble contribution to our knowledge, if not by our countryman at least in our language—I mean the splendid monograph of the Rhizopoda by Professor Leidy—a group of organisms of wonderful structural simplicity, and yet shown to be all sufficient to perform the functions of active life.

Many of the organisms there described are familiar to us, and probably nearly the whole will be found identical with those of our own locality; indeed, Mr. W. Archer, of Dublin, has already found many of them in Ireland. This opens up the interesting and difficult question of distribution, which I shall not attempt to discuss, but merely note the curious coincidence that *Anuræa longispina*, a rotifer of about one-fortieth of an inch in length, should have been found both here and in America at nearly the same time, associated, as it was in our case, with other organisms bearing spinous processes. I trust that that splendid group of creatures to which Anuræa belongs may soon have the same duty rendered it as has been done for the Infusoria, and that we may not have to wait long for a monograph or manual of the Rotatoria, a work which I believe is already in progress.

I confess to having paid perhaps too little heed to the advice upon collecting, which was at hand when I first sought after the minute mysteries of fresh-water life, preferring rather to work away with that enthusiasm which knows no obstacles and heeds no rebuffs

when creatures new to me, and possibly new to science, were to be found, and in seeking them relied rather upon the knowledge gained by experience than any which might be gathered from books.

There appeared two ways open for systematic hunting, and much might be said in favour of both—that first adopted being the plan of naming the localities, and then taking care to place the gathering from each in bottles bearing a conspicuous number, little time being spent in actual examination on the spot. The contents afterwards were carefully scrutinised by the aid of the microscope, which should always be done on the same day, and good note made of the localities from which anything of special interest was derived.

This plan answers very well, and soon gives one considerable knowledge of the inhabitants of a number of habitats, but is open to the objection, especially where long journeys are made, that good gatherings may be taken of things of little interest, and small ones of what is most valuable, thereby wasting much time and possibly missing the opportunity of taking some specimens which are never again to be met with, an experience I have had many times.

The next method is the one I greatly prefer, and always adopt if there is time to carry it out, and that is to ascertain on the spot, as far as possible, what the gathering contains.

I fear many who think microscopic creatures altogether beyond recognition without the aid of a powerful instrument will regard this method as a difficult one, and yet I believe most persons, especially our younger friends, of keen sight, may, with a little study and careful training, become able to identify creatures more minute than would at first seem possible, either with that splendid binocular arrangement, the eyes alone, or, at all events, by the help of a good pocket lens, and a suitable pocket trough, which is of equal importance.

Portable microscopes are made for this purpose, but I have never found the need of one for gatherings made so near home that they may be thoroughly examined the same day.

As an illustration, I may say that I always search my bottles, or rather flat trough, with a pocket lens, for Amœbæ, and usually find no difficulty in ascertaining their presence or absence by this means alone, and I may further note that it has been my pleasure on many occasions to help those who could not see one of these organisms with the aid of the microscope to see one without it, of course, procuring favourable specimens, and placing them in the best possible light.

Choice of apparatus also requires thought, and as I intend that this may be of some real help to those who may follow me in pursuing this delightful study, I must ask the patience of those to

whom it is already familiar in describing my own collecting case. It is a light leathern box, about 12in. × 6in. × 4½in., with smooth handle attached, having twelve or more thin wooden partitions inside arranged for holding a variety of bottles and other things necessary for the purpose.

When complete, it contains four bottles holding about four ounces each, one smaller with a screwed neck for attaching it readily to the pond-stick, and ten, or more, made from glass tubing about 3½in. long by ¾in. diameter, all being numbered and having corks attached by string.

Besides these, a ring net, made of fine French canvas—a material used by ladies, I am told, for the purpose of wool-work—a still finer net of muslin, which will slip over it easily, making the one screwed ring do for both, and being of great use when the specimens sought are too small for the coarser net. A cutting hook also, to screw to the stick; a small grapnel or four-pronged hook, made of soft copper wire, about as thick as a straw (or "No. 9, B.W.G."), cast together by means of lead or soft solder, with a few inches of brass chain attached, weighing about eight ounces altogether.

Then a plaited flaxen or cotton line, which will not gnarl when wet, of fifty or sixty yards in length, and sufficiently strong to stand a considerable pull, enough even to straighten the soft hook, and so set it free should it meet with wood or any hard substance in the water which renders it fast.

A little practice with this apparatus will enable one with a fairly strong arm to throw, or rather sling, it out and gather aquatic plants from a large area, fifty or sixty yards even from any favourable spot for "paying" out the line, where it will meet with no obstacles when running out.

Then a long test-tube, and one or two pipettes, a pair of long forceps, a flat trough, and a "condenser," or contrivance of some kind for filtering out the captures, complete the contents of my case under ordinary circumstances.

How much importance I attach to the use of proper apparatus may be gathered from the fact that I attribute the non-discovery of Leptodora before 1879, not to its non-existence in our locality, but to the want of a suitable net properly used, these creatures escaping through a net too rough, and being unnoticeable, owing to their extreme delicacy on the one hand, and the quantity of alga they are usually taken with on the other, when a net too fine in the mesh is used.

It is quite true that the first one I obtained from Olton reservoir was taken by dipping an inverted bottle to a considerable depth, and then by a quick turn allowing the water to rush in; but I have often repeated the experiment where these creatures are fairly

abundant, and have usually failed to capture a single individual, when a few sweeps with a suitable net would make a good gathering.

Then, as to choice of localities. As you know, water only needs to be exposed to the air, with the addition, perhaps, of a little animal or vegetable matter, for a very short time to become charged with organisms of some kind, and the grand work of Dallinger and Drysdale alone shows of what deep interest even the earliest appearance of flagellate Infusoria is to the careful and skilful observer; but most of the larger and more beautiful forms require a more congenial habitat than this, and therefore those who wish to find and study them must search in spots where conditions are most favourable.

Now let us take a large pool or reservoir, where the use of a boat is out of the question, and see how we are to go about ascertaining what it will yield to our search. We first find out where we may best approach close to the water, and, taking a dip with our screw bottle, soon gain some knowledge about the creatures which may thus be gathered. At the same time we take particular note of the plants growing about the edge of the pool, so as to make sure as soon as possible whether the present water-line is fairly constant, or only very temporary, for we know it is useless searching aquatic plants for good finds unless they are submerged, if not permanently, at least for considerable periods of time.

Well, while I am writing this I have in my mind that elysium of microscopic life, the reservoir at Barnt Green, which, until a large area had been scoured by means of the before-mentioned hook and line, had been considered barren of anything of special interest.

It is certain that when the bottle only was dipped in near the side nothing of more than ordinary character was found; but when the hook was sent flying through the air, and a good bundle of weeds (*Polygonum amphibium*, I believe) was brought to shore from a distance of thirty or forty yards, and carefully examined, living treasures were found in perplexing abundance.

I need scarcely remind our members of the many splendid creatures which that locality yielded, the delight with which we looked upon that rare beauty *Zoothamnium arbuscula*, the lovely groups of rotifer life, *Lacinularia socialis*, the numerous species of Polyzoa, the interesting and typical creature, *Dendrosoma radians*, and hosts of other things which gave a charm to our weekly meetings for a long time, and made us the justifiable envy of our less fortunate neighbours, who only heard of our good fortune, or perhaps got a specimen bottle from our friend Mr. Bolton.

Now I do not think it too much to say that this, like many other localities, had never been thoroughly searched before, and am quite sure that some of our neighbours who regard their districts as unfavourable for pond life may find riches within their reach quite as

great if they will only adopt the same vigorous methods of seeking them.

In looking for specimens of microscopic aquatic life it is necessary to note carefully the conditions which prove most favourable to their existence, for it is certain that the larger our acquaintance with them the more sure are we of success, and the less likely are we to become tired of the pursuit before we have mastered its difficulties.

The water needs to be fairly still for most things, and I have found it most favourable when there is some clay and a fair quantity of vegetable matter in suspension; but a few creatures, as *Hydra vulgaris* and some species of Polyzoa, being voracious feeders, are usually most abundant where the water is in rapid motion, as at the flood-gates and outlets of pools, the weeds, woodwork, or stones in these parts being sometimes truly carpeted with these animals.

(To be continued.)

A STANDARD SIZE OF BODY TUBE.

AS we wish all microscopists to notice the various sizes of body tubes in the market we shall continue to insert the following table for several more numbers:—

Name of Vendor or Maker.	Description of Model.	Diameter of Ocular.	
		Body.	Neck.
		inches & 64ths	inches & 64ths
Powell & Lealand..	Large Stand.....	1·23½-64	58-64
R. & J. Beck.....	National	1·17-64	57-64
Smith & Beck.....	Large stand.....	1·17-64	56-64
Ross & Co.	Ross-Jackson	1·20-64	57-64
Ditto	Ross-Zentmayer ...	1·20-64	57-64
Dancer.....	Large stand.....	1·17-64	57-64
Browning.....	Ordinary stand	1·17-64	54-64
Swift.....	Challenge	1·13-64	56-64
Collins.....	Harley	1·17-64	
Crouch.....	Premier	1·14-64	54-64
Aylward	Working	1·23-64	56-64
Parkes	Students	1· 7-64	*
Zeiss.....	Ordinary	58-64	*
Leitz	Ditto	59-64	*
Engelbert.....	Ditto	1·6-64	*

Upon those stands marked with an asterisk the camera-lucida is not made to fit in the ordinary way.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

CHOLERA.—Dr. Thuillet of the Pasteur Scientific Mission has died at Alexandria of this disease.

THE GINGER BEER PLANT.—Mr. Thomas Bolton writes to say he has a good stock of this plant should any of our readers require it.

MICROSCOPICAL LABELS.—We have received some labels of a new kind from Mr. E. P. Quinn, which promise to be of much use to microscopical mounters. We should like to see a little more information given on the labels of the slides we occasionally purchase.

A STICKLEBACK'S NEST.—We have received from Mr. Bolton a closely-printed *brochure* of 11 pages upon the above subject, illustrated with four plates. It is a very interesting sketch of the habits of this little inhabitant of our ponds and rivers.

BIRMINGHAM NATURAL HISTORY AND MICROSCOPICAL SOCIETY.—The Annual Report and Transactions of this Society has appeared since our last issue. It forms a volume of 133 pages and several beautiful plates. The President's address is full of interest, an abstract of which appears in this number.

FUNGI.—The following is extracted from the *Manchester City News*:—

"Sir,—Would some of your correspondents kindly enlighten us as to the best way to get rid of a troublesome pest in the shape of what I call fungus, which seems peculiar to a part of my garden, and grows rampant, penetrating through nine-inch brickwork, between ceiling and floor above, quite through paper on the floor, and through Brussels carpet, forming into a mushroom-like mass under the hollow part of a fender, which in the first instance of my wife's discovery was quite fast to the floor by the growth of the vegetable. I may explain that the fungus only seems to grow in one particular spot of a few yards in extent. Thinking the application of heat in the affected part would destroy it, we had fixed in the cellar below a good-sized eagle range, with an iron bend leading into the flue of a chimney passing through the floor of the room where the growth was. On opening the flue the bricksetter found

it filled with long strings of "fungus" like leather, which he removed, and thought (like ourselves) when the range was set going our trouble in respect of the growth would be over. After some weeks, however, we find a fresh crop coming up between the crevices in the boards, and again through the paper and carpet, and no doubt is still luxuriant between the ceiling of the cellar below and floor boards. My hope in troubling you is that some correspondent may know of an antidote to destroy the growth.

A VEGETABLE IGNORAMUS."

M. PASTEUR AND HIS PARENTS.—Many of our readers will doubtless be glad to have a translation of M. Pasteur's address to the people of Dôle on the occasion of the affixing of a commemorative tablet on the house in which he was born. The tablet says simply, "Here was born Louis Pasteur, December 27, 1822." M. Kaempfen, who represented the Ministry of Public Instruction and Fine Arts at the ceremony, said:—"In the name of the Government of the Republic, I salute this inscription, which commemorates the fact that in this small house, in this small street, was born one who was to become one of the greatest of scientific men in a century distinguished by the greatness of its science, and who, by his admirable discoveries, has increased the glory of the country and deserved well of all humanity." M. Pasteur's reply was as follows:—"I am deeply touched by the honour which the town of Dôle has conferred upon me; but permit me, while expressing my gratitude, to deprecate this excess of glory. In rendering to me the homage which is usually rendered only to the illustrious dead you encroach too hastily upon the judgment of posterity. Will it ratify your decision? and ought not you, Mr. Mayor, to have prudently warned the Municipal Council against so hasty a resolution? But, having protested against this outburst of an admiration which I do not merit, permit me to say that I am touched to the bottom of my heart. Your sympathy has united in this commemorative tablet two great things which have been at once the passion and the charm of my life—love of science and reverence for the paternal home. O, my father and my mother. O, my dear departed, who so modestly lived in this little house, it is to you that I owe all. Your enthusiasms, my brave mother, you transmitted them to me. If I have always associated the greatness of science with the greatness of the country, it was because I have been full of the sentiments with which you inspired me. And you, my dear father, whose life was as rude as your rude trade, you showed me what patience and sustained effort could accomplish. It is to you that I owe the tenacity of my daily work. Not only had you the persevering qualities which make life useful, but you had an admiration for

great men and great things. "Look above, learn there, seek to rise always," this was your teaching. I see you again, after your day's labour reading some story of battle from a book of contemporary history which recalled to you the glorious epoch which you had witnessed. In teaching me to read, it was your care to teach me the greatness of France. Be blessed, both of you, my dear parents, for what you were, and let me transfer to you the homage which is to-day bestowed upon this house. Gentlemen, I thank you for giving me the opportunity of saying aloud what I have thought for sixty years. I thank you for this celebration and for your reception, and I thank the town of Dôle, which does not forget any of its children and which has borne me in such remembrance."

CHEMICAL CHARACTER OF LIVING PROTOPLASM.—The silver reaction for living protoplasm is not due to aldehyde as Reinke and Mori suppose as it takes place in Spirogyra which contain no aldehyde; neither does this reaction occur with *every* green or chlorophyll-free plant under every circumstance of growth. It occurs only when the protoplasm contains a lecithin compound whereby the chemical resistance is increased so that change does not follow immediately after the first attack on the cells.—J. C. S.

DESTRUCTIVE INSECTS.—In reference to the continued accounts of partial injury by drought and caterpillars received this week from America, "Aphis" calls attention to the mischief now being done in our beanfields by the aphis devastator, plant louse, bean dolphin, or collier, the latter name being given on account of its blackness. The cause is said to be the comparatively dry season in this country, just the contrary to what is said in America, that rains and too much moisture are favourable to the cotton worms. The lateness of the crop in most sections is, however, of the most importance, as that renders it more liable to injury from insects and frost.

Mr. Thomas Brittain, on account of advancing years and failing health, has resigned his position as one of the vice-presidents of the Manchester Microscopical Society. Mr. Brittain was largely instrumental in the establishment of the Society, and was its president during the year 1882.

STEVENS' SILICON.—It may not be generally known to our readers that "Stevens' silicon jewellery-reviver tablet" is little else than a mass of Diatoms. The deposit occurs in the State of Nevada on the Pacific coast of North America, and was at first sight taken for a bed of pure white clay until its chemical composition was ascertained by Professor Silliman.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 35. *NOVEMBER.* 1883.

THE MOUNTING OF POLLEN AS AN OPAQUE OBJECT.*

By W. BLACKBURN, F.R.M.S.

FOR scientific study pollen should be mounted not only as an opaque object, to be viewed by light reflected from its upper surface, but also immersed in suitable media, which render it more capable of transmitting light, when it may be viewed as a transparent object. Some kinds derive an advantage from being stained. My present purpose is to show how it may best be made to retain its natural appearance as an object, in many cases, of exquisite beauty, by being mounted *dry* upon the anther from which it has escaped. When mounted in this way, it should, of course, be viewed through the binocular microscope.

The collection and drying of the anthers. The flowers should be gathered when full-blown, just before they begin to fade. The petals may be turned down or removed, if necessary, so as to expose the central organs, and the stamens then cut with fine scissors a short distance from the anthers, the latter being allowed to fall upon clean writing paper, when a selection may be made with a pocket lens of the specimens most suitable for preservation. Some mounters place these in pill-boxes to dry; but as they are liable to get shaken in these receptacles, I prefer to lay them carefully on a piece of clean writing-paper, previously folded, with the name and date outside, and refolding without pressure place the packet with others in a box, where I let it remain in oblivion for twelve months or perhaps two years. In the case of large anthers, such as the *Lilium auratum*, it may be advisable to lay them on a piece of blotting-paper, inside the writing paper, in order the better to

* Demonstration notes read before the Mounting Section of the Manchester Microscopical Society, on Oct. 18th.

absorb moisture, care being taken, when mounting, to remove any adherent fibres of the blotting material with a needle.

Cells and cements to be used in mounting. Thin metal and bone cells are the best for this purpose. The metal ones may be either of brass or block tin. For small anthers, such as those of *Ranunculus aquatalis*, the ordinary half-inch brass cells are suitable. For larger anthers, or groups of stamens and anthers, such as may be made from the *Abutilon*, five-eighths and three-quarters of an inch bone cells are the best. Bone is much preferable to metal for its adhesive capacity when affixed to glass, and the bone cells usually sold have their surfaces "truer" than those of metal. The most adhesive cements are liquid marine glue and "quick-setting" gold-size. I use the latter. Its solvent is benzole, not alcohol. It is very workable, readily dries, is strongly adhesive, and does not become useless, like "brown cement," by evaporation, as the addition of benzole always restores its "condition." To affix the cell to the glass slip, run a ring of cement on the slip with the turn-table, and paint one surface of the cell with the same. Allow them to dry; but before the cement becomes hard, perhaps in an hour, place the cell, cement downwards, upon the ring of cement on the slip, and gently press them together; then hold the slip over the flame of a spirit-lamp for about a minute, at a sufficient distance to avoid boiling the cement, if possible, as the bubbles of air formed will interfere with the adhesion of the cell, yet sufficiently near to insure the melting of the cement and the evaporation of some of its moisture. Then remove, and placing another slip of glass on the top of the cell, clamp the whole together with an "American peg" (a form of clothes-peg to be obtained at any brush-maker's). Let it remain under pressure for twelve hours, when the cell will be found immovable. This is a suitable method for mounting objects in spirit with glass cells, as I have found that absolute alcohol has no effect upon the cement after this process.

When you are about to *mount the anthers*, paint the bottom of the cell with "matt black," using the turn-table, so as to distribute it evenly over the glass. When the "black" is partially dry, place the anthers upon it in suitable positions, and gently press them with a blunt needle so as to secure their adhesion to the cement. The best effect will be produced when the anthers are arranged in the centre of the cell with the stamens directed to one side, as in their natural position. This, however, may be left to the taste of the mounter; and in many cases no arrangement of this kind will be required, as one anther will be found large enough to fill the cell. When there is found to be a deficiency of pollen on any of the anthers after mounting, some pollen may be taken on the point of a needle from other anthers and placed in position on the bare parts, when gently breathing upon it will fix it.

To close the cell. This process should be left to the following day. First pick out, under a lens, with a needle, any foreign particles that may have obtained admission. Then run a thin ring of the gold-size round the edge of the cell with the turn-table. Place a cover-glass on the top, and having firmly pressed it into position, put on a steel spring-clip, with moderate pressure only. In a few hours the clip may be removed, and the slide put away to dry. In a few days another ring of cement may be put on, and the slide finished according to individual taste; but if plenty of time be not taken over the final processes, so as to insure perfect dryness of the inner rings of cement before applying fresh ones, it will probably be found in a few weeks that the inner surface of the cover-glass will have minute drops of moisture upon it, interfering considerably with the definition of the object. The best advice to the "dry" mounter is "Festina lente."

THE MANCHESTER MICROSCOPICAL SOCIETY.

THE ordinary monthly meeting of the Manchester Microscopical Society and the annual soirée of the mounting section were held on Thursday evening, October 4th, in the Lecture Hall of the Athenæum, George-street. There was an excellent exhibition of amateur work and a display of rare and valuable slides. There was a large gathering of members and their friends, including many ladies. Shortly after seven o'clock the chair was taken by the President, Mr. W. Blackburn, F.R.M.S., who was supported on the platform by Mr. G. E. Davis, F.C.S., F.R.M.S., Mr. Thomas Brittain, Mr. C. L. Cook, Mr. John Aitkin, F.G.S., Dr. Samelson, Dr. Hewitt, and other members.

An interesting item of the evening's programme was the presentation of an illuminated address, beautifully got up and bound in the form of an album, to Mr. Thomas Brittain, who, owing to ill health and advancing years, has felt compelled to resign the position of a vice-president of the society. He served as president in 1882. Mr. Reston, photographer, Stretford, has taken an autotype portrait of Mr. Brittain, and this is to hang in the meeting-room of the society.

The Chairman said he had much pleasure in making this presentation on behalf of the members of the society to Mr. Brittain. It was the original intention of the Council to present an illuminated address only, but there was such a liberal response to the application for subscriptions that they were able to do more. They received numerous suggestions from the members as to the

form the testimonial should take in addition to the address, and the suggestion which commended itself to the approval of the Council was an autotype portrait of Mr. Brittain, which should hang in the meeting-room. The Council hoped that Mr. Brittain would accept it as a form of testimonial, as it conferred as much honour upon him as if it had assumed any other form. The Chairman then read the address, and handed the album to Mr. Brittain.

The address is as follows:—

THE MANCHESTER MICRÓSCOPICAL SOCIETY.

To THOMAS BRITTAIN, ESQ.,

DEAR SIR,

It is with deep regret that we, the undersigned members of this Society, have learned that your failing health, in connection with your advancing years, has caused you to resign the office of *Vice-President*, which you have held since the formation of the Society, with the exception of one year, during which you filled the highest office; and that the same cause will probably render impossible your attendance at our future meetings.

Whilst we offer you the assurance of our sympathy on this occasion, we regard it as a suitable opportunity for presenting a *Testimonial* of our esteem for your personal character and our appreciation of your past services, rendered as these have been, not only in behalf of this Society, which has been largely benefited by your assistance and counsel, but also in the promotion of a general interest in the study of nature by means of the microscope, which has been, we believe, one of the dearest objects of your life during the last forty years.

It must, we feel assured, have been a source of satisfaction to you to have seen this interest become more generally diffused through all classes of intelligent society during that period, and to know that this result is to a great extent owing to minds like your own, endowed with an ardent love of nature, a capacity to acquire considerable familiarity with some of its various phases, an eloquence and earnestness at all times in the advocacy of truth, and generosity in imparting knowledge.

We might remind you of special services which you have rendered in promoting the beneficial study of nature, and especially of your favourite pursuit, cryptogamic botany. We believe, however, that your influence has been extensively and personally felt, and that the recorded transactions of our own and kindred Societies afford appreciative testimony of your past usefulness.

The unselfish and generous assistance which you have so freely given to microscopical students, and more particularly to the young, has greatly impressed us with your large-heartedness, and must command the esteem of all who know you.

It is our sincere hope that you may live to enjoy during many more years the fruits of a well-spent life, in health sufficient to pursue your favourite studies; that this *Testimonial* may serve to remind you that your labours have not been in vain, but have been appreciated by a large circle of friends and admirers; and that you may still be able to teach that, in the contemplation of nature,

"the heart
May give a useful lesson to the head,
And learning wiser grow without his books."

Believing as we do that the present and future members of this Society will value a permanent record of the personal appearance of its eldest and one of its most enthusiastic leaders, we have had prepared, with your kind permission,

an autotype portrait, to hang in our room of meeting; and we hope that our energies will be stimulated to greater endeavours when we look at this speaking likeness, which seems to say to us, almost in words, "Whatever you do, do it with all your might."

Mr. Brittain said he did not know that any words he could command would adequately express the gratitude which he felt at this unexpected kindness to him. He had been a lover of the microscope for nearly half a century, and it had been the greatest pleasure of his life. Forty years ago it was a difficult thing to organise anything like a microscopical society, but in 1858 he made an attempt to establish one. He found that a number of gentlemen were willing to give their assistance, and finally a society was got together and it became a branch of the Literary and Philosophical Society, the subscription being two guineas a year. That did not meet his object, as he wished to make the microscope a popular instrument of education. He felt that in the microscope a field of usefulness was open to him which would bring reward to him—not a reward like the present one, he had never expected that—but he anticipated a feeling of gratitude from those in whose services he was labouring. He gave lectures throughout Lancashire and Yorkshire. One or two things in connection with this Society gave him profound pleasure; one being the wonderful progress of the younger members in the study of the microscope. They had come there devoid of any knowledge of microscopy, and, to his astonishment, in six or twelve months they had been able, a great many of them, to mount objects requiring great skill and practice. If there was a lasting pleasure in life it was to be found in the study of nature in its minutest aspect, and the microscope gave us that advantage.

Mr. W. Stanley, the Hon. Sec. of the mounting section, said that he came forward as perhaps the youngest pupil of Mr. Brittain, in order to express the feeling of pleasure with which he saw the Manchester Microscopical Society (one of the most successful societies of recent years, and one whose number of members was equal to many of the leading societies) recognise the valuable services of Mr. Brittain.

The Chairman then said: Ladies and Gentlemen, before we proceed to the inspection of the amateur work and microscopical specimens arranged for your entertainment, a few remarks upon the objects and aims of our society may not be inappropriate.

About five years ago, before this Society was in existence, I happened to be in the city of Berlin, and amongst the many sights that delight and instruct the visitor to the German capital I found that it possessed a permanent exhibition of microscopes and microscopical objects. It was called the "Microscopical Aquarium," because its chief purpose was to exhibit those vital

phenomena which are so wonderfully visible in many of the minute inhabitants of our ponds and ditches. Some thirty or forty microscopes, all of the continental model, were placed upon tables suitably arranged, each instrument with some interesting specimen, either living or preserved, displayed in it. This exhibition was open daily, and the specimens were frequently changed, so that a constant visitor might in time become familiar with the microscopical appearances of a great variety of natural objects, and would probably soon become an ardent student of nature, and possess a microscope of his own. What the Germans were, and probably *are* doing in their permanent exhibition, we, as a Microscopical Society, endeavour to do in perhaps a more spasmodic manner, but we hope not less effectually, at our soirées and open exhibitions; we try to infuse into our fellow-beings some of that love of nature which we all possess, whether we are microscopists or not, and which never becomes less by distribution. But we also have a higher aim than this. If each member of this society were to interrogate his own consciousness as to the motives which urged him to join us, I am afraid that such introspection would not, in every case, afford a flattering view of his principles of action. It is not, however, our province to inquire into these motives, but to welcome all comers who are desirous of placing a foot upon the lowest rung of the ladder, the ascent of which will make them earnest students of nature. It is not to be expected that many of us will succeed in climbing very high, and it is, indeed, probable that some of us come under the appellation of the "playing microscopist." With regard to this individual the Rev. J. J. Halley, in his presidential address to the Microscopical Society of Victoria, says :—

"We will grant that in his hands the instrument is a plaything and nothing more, that he looks at the wondrous beauties revealed merely to please the eye, that he peers into quaint and curious forms merely to satisfy curiosity, that the valve of a diatom is interesting to him merely as it is strange, and that the organs of an insect or the home of a Bryozoon only allure as they are novel. In this there is nothing to be despised. The great order of the Bimana must be amused, and the more rational the amusement the better; and surely it is not less rational to find amusement in examining the wonders of Nature,—her painting of marvellous beauty, her sculpturing of unrivalled forms,—than in turning over the prints of man, or spending time collecting and examining his effigies; surely as reasonable as counting the pips on a card, as cannoning ivory balls, or bouncing indiarubber ones over a net. We will not then push out of existence the playing microscopist," but "will welcome all such to our gatherings, assuring them that they will find here much to amuse them if they do not care to learn."

I hope, however, in our own Society, that by association with those who regard play as merely a wholesome diversion from real work, our play-fellows may at last become help-mates in the discovery of truth, and so add a few stones to that great temple of knowledge, the building of which has been committed to our care by our predecessors in the world's history, and which we hope to bequeath to our posterity with greater completeness and richer adornment than before. This, then, is the higher aim which we ought all to possess in being members of a microscopical society. That some of our members have this aim in view is attested by the nature of the papers that are occasionally read at our ordinary meetings. I am sorry to say that such papers are not sufficiently numerous to warrant us in drawing the inference that we are all endeavouring to add to the stock of human knowledge. There is other work, however, to be done by a microscopical society than the writing of papers; so that whilst some are following the life-history of a species, or tracing the relations or modifications of an organ, or, perhaps, investigating the relation between structure and function in some ill-understood region of the organic world, there are others with equal patience endeavouring to discover the best methods of preserving the results of such research, and so of securing for ever, free from change, specimens that would otherwise be required to be prepared afresh, whenever it was necessary to exhibit a type or demonstrate a discovery. This part of the work of our Society is open for your inspection to-night in the illustrations of permanent mounting contributed by the members of our Mounting Section, to which I cordially invite your earnest attention. There is no process too trivial for our mounting department to consider in its endeavour to instruct its members in the art of forming permanent records of the true and the beautiful in nature; and the excellence of the results attained by the careful work of some of the members is sufficient evidence of the successful application of their skill and ingenuity. I can assure those who intend to join our Society that its Mounting Section will soon enable them to lay up a store of amusement and instruction for themselves and their friends during the winter evenings that are approaching, and may possibly form a stepping-stone to the higher region of scientific research and discovery.

Some interesting processes of a popular nature will be shown to you to-night by some of the members of the section. Mr. Stanley will mount Mosses and Hepatics in glycerine jelly by the boiling process; Mr. Lofthouse will extract and mount the tongue of the bee; Mr. Johnson will mount *Drosera rotundifolia* in carbolized water; Mr. Hall will show the process of cell-making; Mr. Ward will illustrate the art of finishing the slide in the most attractive manner with a ring of cement; and other members have volunteered to exhibit equally interesting processes.

In conclusion, I hope you will pass a pleasant evening in examining the microscopes and the objects displayed in them.

The meeting then resolved itself into a conversazione, and the soirée was a success in every respect.

BIRMINGHAM MICROSCOPICAL SOCIETY.

ABSTRACT OF PRESIDENT'S ADDRESS, 1883.

(Continued from page 293.)

I GENERALLY avoid those ponds altogether where the water looks black and smells strongly of that curious alga Oscillatoria, interesting as it is, for I expect to find little else there, and if the situation is much exposed to the wind the quiet spots where the weeds grow pretty freely in deep water are to be sought in preference to all others.

It is quite true that in warm summer time a dip in any part is sure to yield something which will repay the search, but in winter or cold weather only the more sheltered spots are worth much attention, and so obvious does this seem that I should scarcely deem it worthy of mention, only that evidence is plentiful that it is often entirely overlooked even by those who are presumed to be fairly expert.

I have often felt amused—and the source of amusement is still open to us—at the many fanciful things which have been said about that delightful object for the microscope, *Volvox globator*. How is it, it is asked, that it is found in abundance one day and has entirely disappeared the next; and what becomes of it in winter? Does it assume some strange garb and pass unrecognised and unrecognisable in its disguise, or is its existence left to be so-called winter spores seen in the *Volvox aureus* of Ehrenberg, which are supposed to sink in the mud only to appear again with the coming sunshine?

Now I made Volvox my special exhibit so many winters at our Midland Institute Soirées that I became fairly ashamed to show it; and as it is a most difficult thing to keep in artificial aquaria for any considerable time, I had often to renew my stock from some natural source, which I was nearly always able to do, in summer or winter.

Whence, then, come all these mysteries about its appearance to-day and its disappearance to-morrow? Why, the fact is, many

who search ponds for this and other free organisms do not take the necessary means to find out whether it is present or not, and unless a few dips suffice to secure specimens it is at once settled that the thing is not there.

The explanation is that Volvox is greatly stimulated by light and warmth, as is usually the case with plant life, and under these favourable influences it will not only increase at a great speed, but will roll through the water in every direction, so that the most haphazard dip with a bottle is sure to secure specimens; and I have many times seen it even covering the banks like a green scum where the water has receded and left it stranded, as we see marine objects on the sea-shore.

But in winter or times of extreme cold it makes its retreat from the "weather" side of the water, and is to be sought very near the bottom in some shallow part where the weeds not only give it shelter, but find it anchorage too; and knowing these spots at my particular hunting-grounds, I have often stood upon the ice and, after breaking a hole with a hammer, dipped in my bottle or swept beneath with my canvas net and gathered it in any desirable quantity.

Of course it may happen that the particular patches of weeds among which it is snugly nestling are out of reach unless we are equipped with water-tight boots and prepared to risk their efficacy for keeping the feet dry; but, though I do not wish to impress upon you that I think when it is once present it always remains so, I am sure a more thorough search will prove that the vagaries with which this organism is credited are only the fancies of the insufficiently persevering pond-hunter, and that there is no period of the year when it is not to be found.

If we make a sudden jump from the Vegetable to the Animal Kingdom, perhaps there are few creatures of more general interest and beauty than the thecated rotifers, Floscularia, Melicerta, Œcistes, etc., and a study of these indicates beyond a doubt that in active life they require a plentiful supply of decayed vegetable matter with which to build up their tiny structures, and, as I shall show you, I have made good use of this knowledge in collecting and keeping them afterwards.

Next to these, perhaps, should be placed that most beautiful of the free rotifers, *Notommata Brachionus*, which came to my hands in abundance in the following instructive way.

I was driving along a country road, with a keen eye for likely ditches or puddles, when I came to a heap of rubbish with just a small patch of water at its base not more than three inches deep in the wheel-ruts or holes made by the feet of cattle.

This I thought worth trying, and to my surprise found it contained *Pandorina morum*, and that charming rotifer before named.

Of course, I took a good gathering. The only regret was that I felt sure that a few days without rain would entirely obliterate this very temporary habitat, and so it proved, for on going to the same place a week afterwards not a drop of water was to be seen there; indeed, so dry and hard had the ground become that I felt almost in doubt if I had not missed the exact spot. However, I was quite unwilling to return without a further effort to find this particular rotifer, as I felt quite sure this could be only a place where it had come by some extraordinary means, and I therefore resolved to re-search the only two ponds I knew in the immediate neighbourhood, which I did, entirely without success.

I then looked out for one of those useful but innocent auxiliaries to natural science, a farm labourer, and having got over the difficulty as to what was meant by a pond by explaining that it was a hole in a field where the cattle and sheep get water, received the information that there was a farmer who not only "kep a good dell o' cattle, but that he had a field up the bonk with a hole where they got water," and as far as he knew it never dried up.

To this "bonk" and this "hole" I made my way, the latter being quite out of view from even a few yards off, and you may guess my joy when I found that this was teeming with *Notommata Brachionus*, many of them loaded with their pendulous eggs, and that the pond also contained hosts of other good things, among which was that curious organism which afterwards proved to be *Rhipidodendron Huxleyi*.

I had not been there long when some sheep came near me, as I thought, to see what I was about, but which my bucolic guide explained in a less flattering way, telling me that they had come to drink, and here was a ready solution to the problem as to how the rotifers had got to the puddle on the roadside. These unintentional distributors of microscopic life would go to the pond and paddle in the water, and then readily carry either the eggs or the rotifers themselves upon their feet, and possibly leave some behind in the first puddle they passed through on their way.

Next to the desirability of successful search for microscopic fresh-water life comes the natural wish to be able to keep it, and, if I may use the word, cultivate it, and here let me put in an earnest plea for an extensive adoption of means to this end.

Like all lovers of this study, I have felt saddened to see the beautiful creatures, which I have perhaps been many miles to get, and which have afforded so much delight to myself and my friends, gradually dwindling and dying in the little glass bottles or, to them, fatal prisons in which I had placed them, and like others, too, have made many attempts to keep them in all the charming freshness of active life, as I found them in their natural habitats, in indoor aquaria.

Indeed, it is a fact, as proved by my study of Dendrosoma alone, that if these things can by any means be kept in active life, it only needs careful observation to unfold their history with all its interest and absorbing attractiveness.

I have not wondered that many naturalists have from time to time spoken in high satisfaction of their success in maintaining and increasing their stock of such things as Melicerta and even Volvox, with other organisms of like interest, and am free to confess that my own indoor aquaria have assumed a very abnormal, not to say obstructive, growth, often proving successful, however, far beyond my expectation. But I have found that, with all ordinary care, the creatures and plants too are stimulated into such rapid changes that sooner or later they come to grief, if I may use that expressive sporting phrase, and that one needs to begin over and over again.

Now I was under considerable doubt as to whether a small pond constructed in my garden would be sufficiently successful to repay the somewhat heavy cost; whether the inevitable town surroundings of bricks and mortar, and the accompanying smoky and often dusty atmosphere would not overcome anything I might do in providing other more favourable conditions for the existence of these delicate organisms, and I am pleased, therefore, to be able to say that the plan has answered admirably, and that, in addition to the microscope and the complement of books which a student needs, I most earnestly commend all lovers of this study to acquire a garden-pond.

My own has not only furnished me with a grand supply of such things as Melicerta, Stephanoceros, and several kinds of Floscules, Stentors, Hydra, both *viridis* and *vulgaris*, Amœba, innumerable infusoria and algæ, and some new or rare Desmids, as noted by Mr. Wills, but has given me, in addition, a constant supply of such rarities as *Œcistes umbella*, *Melicerta annulata* and *Tubicularia naias*, with Tardigrada and free rotifers, etc., in abundance. In fact, I have only to complain of an *embarras de richesses*, and regret that want of time has prevented me doing as much with them as I could have wished.

Though the construction of a pond, or what in this case may be better understood if called a fountain basin without the fountain, is a simple matter, yet I know from experience that it is by no means certain to be made successful at the first attempt. Mine is a brick structure of about eight feet outside diameter, and about two feet six inches in depth, measured from the top edge to the base; the inside is made to slope at a good angle, which is very important. It stands about eighteen inches above the level of the surrounding ground, making nice sloping banks for about half its circumference, the inside being asphalted, which renders the whole perfectly water-tight. It has an outlet and a temporary means of supplying water, but the former is never required, and with the bountiful supply of

rain we have had during the past few years, it has rarely been necessary to add any water whatever, occasionally just a little to keep up the level during any warm and dry period we may have happened to have, few of which have troubled us for a long time past.

The bottom and sides have a good layer of sandstone rubble with a little clay, furnishing innumerable nooks and crevices, where plants may root and animals may hide, no attempt whatever being made at architectural ornamentation. The rubble, however, is carried to and over the edge of the brickwork, which it completely hides, and is continued down the outside, making just a bit of ordinary garden rock-work, planted in the usual way with ferns, saxifrages, etc., forming in summer time a perfect maze of plant life, shading the water from some of the sun's rays, and affording shelter for the numerous reptiles which also find a home in or about the pond. The whole thing looks like a very humble attempt at imitation of one of those charming natural ponds one finds among the broken rocks on the rugged mountains of North Wales.

The botanical specimens here grown are very numerous, and were selected, I am afraid, on the principle adopted by the man who ascertained what were the best remedies for a cold, and then endeavoured to take the whole of them. Every plant which appeared particularly favourable to microscopic life has been introduced in some way or other, the result being that the place is crowded beyond all need with such plants as Chara, Nitella, Anacharis, Myriophyllum, Callitriche, Potamogeton, Lemna, etc., while the sides near the water are clothed with Caltha, Iris, Carex, and several mosses.

Besides the above there is a plentiful stock of a plant which has proved one of the most fruitful sources of some of the thecated rotifers. It is a grass which, my botanical friends inform me, is *Poa fluitans*, and wherever this is found growing in fairly deep water by the pond-hunter, I advise him to pull up some and carefully examine the innumerable small fibres which form its roots.

This plant seems to serve the tube-dwelling rotifers, as the reindeer does the Laplander, or the palm-tree the Asiatic or African, for it appears to find both food and clothing in abundance, and I have little doubt that the presence of the rare rotifers before-named is due to this cause. One of my first finds among its roots was a Floscule, of extraordinary size and beauty. I think I exhibited some at our meetings having a length of over an eighth of an inch, and a Melicerta, if not an unrecorded variety, at least presenting many differences from the well-known *Melicerta ringens;* and, lastly, the two already-named rarities *Œcistes umbella* and *Tubicolaria naias.*

Of course, the convervoid algæ grow much too fast in summer,

and it is sometimes necessary to take some out carefully, disturbing the general arrangement as little as possible.

May I append to this an expression of my hearty desire that instead of the hap-hazard way in which suitable ponds for the preservation and growth of microscopic life are allowed to exist, efforts should be made to get those worthy of consideration protected, and influence used to establish new ones in places where they would cost nothing more than a trifling first outlay, and would prove centres of attraction to the microscopist, botanist, and others. How often have I heard it regretted that those famous preserves in Sutton Park known to many as "Webb's Stews," should have been so ruthlessly and needlessly destroyed, and yet these things could probably be replaced in the same grounds at a very trifling cost compared with the pleasure they would yield.

Even to those who do not pay any special attention to microscopic life, I can strongly commend a garden pond, provided that art is used only as far as necessary for furnishing a perfectly water-tight basin, and that the rest is made as natural and wild as may be, for, besides the plants, the creatures of large size, as frogs, toads, water-tortoises, newts, snails, and insects afford so much interest to every lover of nature that the garden pond becomes a never-failing source of pleasure.

WATER, WATER ANALYSIS, AND THE MICROSCOPE.

II.

ONE of the most popular subjects in connection with microscopy, and one which has always been well received by mixed audiencies, has been the exhibition upon the screen by means of the oxyhydrogen microscope of the organisms found in water.

We have often feared that the zeal of the exhibitor has on many occasions outrun his discretion, and in his anxiety to produce something remarkable for his listeners has led them to believe that all waters abound with organisms as curious in their structure, and as various in form as those he has pleasure in exhibiting to them. This is not the case however. One may get many dips from a river, canal, or pond without meeting with any living creature; but it is more than probable that some inhabitants of the waters may be met with, though not in the quantities some would have us believe.

The water supply taken from our service pipes is popularly supposed to be teeming with organisms of a kind capable of

doing us grievous bodily harm, and the young microscopist often thinks that all he has to do is to place a few drops of such water upon a glass slide, and look at it under the Microscope, when all the forms imaginable will present themselves. No greater mistake could be made—organisms are present to a greater or less extent in all water supplies, but the water from service pipes, as a rule, contain so few of them that some special method of operation and examination is necessary on the part of the microscopist.

Some year or so ago we were very much amused at seeing a report of the London water supply containing the statement that this water contained "moving organisms." We do not know whether this was intended as a discovery. If so it is probable that a more careful search would have discovered them at a much earlier date.

In America the use of the Microscope is better known in connection with water analysis than it is with us, and it would be well if some of our chemists would abandon their inaccurate methods of chemical analysis, and call in the Microscope to their aid. There *is* something to be seen in water if the operation of "seeing" is gone about in the right way, and as an instance of this we give illustrations of the residues of two samples of water used for drinking purposes.

Fig. 71.

Fig. 72.

Small entomostraca, diatoms, and small rotifers abound in this residue, and it may be as well to state that a drop of the water, if placed simply on the glass slip, and examined under the Microscope, would most probably show nothing at all. The fact is that the organisms are so few in number, and diffused through such a large volume of water, that they must be concentrated ere they can be detected, and this may be done in the following manner:—

Professor Romyn Hitchcock, the able editor of the *American Monthly Microscopical Journal*, in 1881, gave instructions to his correspondents as follows:—"The Editor would consider it a great favour if correspondents in different cities would send him filterings from their water supplies, from time to time, for com-

parison. They can be readily collected by attaching a bag of fine cloth to the faucet (tap), and running the water for an hour or so. A large bag about six inches deep is preferable to a small one, as the water then flows more freely. The sediment should be washed into a conical glass, and allowed to settle."

Even before this, Professor W. G. Farlow issued a small *brochure* illustrated with two plates, entitled "On some impurities of Drinking Water caused by vegetable growths," which was quite sufficient to allay any anxiety engendered by reading the sensational articles often appearing in our papers respecting water supply.

In 1881 the Boston (U.S.A.) water supply was made the subject of many complaints, a strong "cucumber" taste was developed in it, much correspondence taking place upon the subject in the Boston papers. Professor Ira Remsen undertook to investigate the matter, and his report confirms what we have already said regarding the value of chemical analysis in the last chapter. Professor Ira Remsen writes: — "Having failed by chemical means to determine whether the substance which causes the 'cucumber taste' is at the bottom of the pond or not, I now undertook a special examination." Further on he states, "There is evidently something at the bottom which, by contact with air, is capable of giving off an odour. An examination soon revealed the presence of green masses, varying in size from that of a pin head to that of a pea. These were present in considerable quantity, and in allowing the vessels containing the mud to stand quietly for a short time the green masses rose to the surface of the mud." Further investigation showed this green substance to be algæ of the Nostoc family, and the Nostocs are known to give off a disagreeable odour when decaying. This, however, was not the cause of the "cucumber taste." Finally, an examination of the *debris* collected at one of the effluent sluices showed an accumulation of *Spongilla fluviatilis*, the fresh-water sponge, which, while living, has a very strong odour, intensified by death, and Professor Alpheus Hyatt reported "that the odour of the sponge shown me by Professor Remsen is like that of the water strongly intensified."

This little episode shows the value of microscopical analysis, which is even more strongly exhibited by Professor Elwyn Waller's report on the Croton Water of 1881. Dr. Torrey was called upon to report upon the odour of the Croton water as early as 1859, and there is little doubt but that the plants alluded to in his report were *Cœlosphærium* and *Anabæna*. In Professor Waller's report it is shown that more than sixty towns are occasionally troubled with the odour of the water supplied to them.

Of course the water of a stagnant pond is always found literally teeming with organisms of all kinds, and the reservoirs of the water supply of our British cities afford the microscopist many a good

day's sport. Our rivers also afford us many specimens if we are careful in selecting our hunting ground, and in concentrating our specimens. The following illustrations represent organisms taken from the Thames at Richmond, not, be it understood, a single

Fig. 73.

Fig. 74.

dip of the water taken hap-hazard, but carefully filtered, whereby the excess water is allowed to escape, and the organisms brought into a smaller bulk.

The water from service pipes requires to be very much concentrated before anything can be obtained fit for examination. The fine linen bag should be tied round the tap, and the water allowed to run for some hours, the bag then being carefully washed into a conical test glass, and allowed to settle. Another method may be employed, viz., using a fine linen filter to Maignen's "Filtre Rapide," described in our first article. By this means the animal life suffers less than is the case when the bag is tied direct to the tap. The two next figures show what can be obtained from an ordinary service pipe by these means :—

Fig. 75.

Fig. 76.

In judging of the quality of water from the results of a micro-

scopical analysis the analyst should not be guided by the *number* of the organisms, so much as by their character—although the field of Fig. 75 is nearly as full as that of Fig. 76 we should imagine that chemically the former water would be much the better of the two, and it should be once for all known that some living organisms are only to be found in the purest water, so that the simple finding of "moving organisms" is not by any means a sign that such water is unfit for drinking purposes.

It is folly to think of improving our water supply while house cisterns are so ill attended to; some householders never think for a moment that their cistern should *ever* be cleaned out. The writer has seen some awful conditions of these reservoirs, dark and dirty, contaminated by dead birds, mice, and even cats, in a pleasant state of putrefaction, covered with masses of fungi, aquatic worms of all kinds moving amongst the filaments of conferva found growing upon sides of the cistern. Fig. 77 exhibits the character of the residue from a water of this kind taken from a "Filtre Rapide" after much concentration, and it is hoped that the perusal of these few remarks will tend to dispel the notion that because organisms exist in the water, that water must necessarily be unwholesome; to teach us that organisms do not usually exist in immense quantities in small quantities of water; and that cisterns sometimes require cleaning out.

Fig. 77.

KLEIN AND PASTEUR.

THE recent "Supplement" to the "Report of the Local Government Board for 1881-2" will be valued not only by all who take an interest in the germ theory of disease, but by all students of micro-biology (and, it may be added, by all serious students of cryptogamic botany), specially on account of the paper by Dr. Klein on "The Relation of Pathogenic to Septic Bacteria" which it contains. The delay in the publication of this official account of Klein's researches has, no doubt, to some extent, been due to the length of time required for the preparation of the beautiful plates with which this and the other papers in the "Supplement" are illustrated. Few can look at these plates and doubt that in the

various bacteria to which so much attention has latterly been given we have the true causes of zymotic diseases. Very erroneous and imperfect accounts of the contents of Klein's paper have been published, and it is desirable that these should be corrected. For those of our readers who are not familiar with the subject, it may be explained that, broadly speaking, there are two classes of fungi, to which order, provisionally, the bacteria may be said to belong. These two classes are known as saprophytes and parasites. The former absorb their nutriment from the remains of dead organisms or from organic compounds formed by living organisms, and may therefore be said to fulfil an innocuous if not a useful purpose in nature; the latter absorb their nutriment from living organisms which they thus kill, and they have therefore essentially the nature of disease. In the familiar vegetable world, for instance, mushrooms belong to the former class, and the potato disease to the latter. Now the idea has been enunciated by our townsman, Dr. William Roberts, Von Nägeli, Buchner, and others, that the parasites are merely "sports" from the saprophytes, resulting from special conditions of culture, and that the two classes are mutually convertible. The importance of this idea, as bearing upon the genesis and extinction of zymotic diseases, is obvious, and the primary purpose of Klein's researches has been to test this question, though in the pursuit of this object he has been led to examine other issues which have lately been brought very prominently before the public, and which, apart from their general theoretic bearing, have a special, or, so to speak, individual importance. There are two bacilli which are remarkably typical of the two classes of fungi referred to. One is known as *Bacillus subtilis;* it grows in a decoction of hay, or in what may be spoken of, in familiar terms, as hay broth, and it is perfectly harmless. The other is known as *Bacillus anthracis*, and it has not only swept away enormous numbers of sheep in France and elsewhere, but develops in man himself as the terrible "woolsorters' disease."

Now to all appearance these two bacilli are identical in form and development; the only perceptible difference being that the harmless bacillus exhibits the power of motion in the fluids in which it is cultivated, while the deadly contagium is motionless. Here, then, apparently, there is a *prima facie* relation involving a possibility of artificially converting one into the other. At this point Pasteur's recent researches become suggestive. It will be remembered that Pasteur, having already succeeded in producing, in the specific microscopic organism which he found associated with chicken cholera, some mysterious modification which he calls "attenuation," discovered that, after inoculation with such artificially cultivated and modified virus, fowls were protected against the ordinarily fatal consequences of subsequent inoculation with unmodified virus.

Encouraged by this result, Pasteur next turned his attention to anthrax. There are two modes in which micro-organisms spread themselves. One is by a process of cell division, which may be likened to the growth of branches on trees and to the production of new trees from branches which have been separated from the parent and caused to take root in the earth. The other mode is by the production of rows of brilliant corpuscles or spores along the rod-like bacilli, like the *sori* or spangles on the backs of fern fronds. Having given birth to these spores the parent rods break up, each of the spores being capable of producing a new crop. This method may be likened to the production of new plants from seed. The *Bacillus anthracis* not only grows by cell division but produces spores. As these spores, like ordinary seeds, retain their vitality and specific character under conditions which would kill or modify the parent plants, Pasteur came to the conclusion that it would be desirable to eliminate them from his artificial cultures. In his original paper he claims to have found that, grown at 42 deg. Centigrade, the *Bacillus anthracis* produces no spores, and that, having thus got rid of the spores, he has been able so to "attenuate" the sterile bacilli as to convert them into a "vaccine" against anthrax, just as he had already produced from the virus of chicken cholera a vaccine against that disease. According to M. Paul Bert, not less than 400,000 sheep have been in consequence successfully vaccinated in France against a disease which previously cost the farmers of France about £1,000,000 per annum. It is not denied that failures have occurred, and considering the nicety of the process and the still mysterious character of the whole subject, this is not surprising. It cannot as yet be said, either, how long the protective influence lasts. But meantime there is the undoubted fact that the ruinous mortality amongst sheep in France from anthrax has been enormously reduced. Pasteur asserts that the "attenuating" influence by means of which he has succeeded in obtaining these results is traceable simply to the presence of oxygen; and should this prove to be so, the suggestiveness of the discovery is very great. Assuming, for instance, it may be argued, the presence of organic matter in ill-ventilated sewers, may not the absence of a sufficient supply of oxygen result in the conversion of the harmless saprophytes of decay into the deadly parasites of typhoid and other diseases? Or, again, given existence in ill-ventilated dwellings and close bedrooms, or inefficient aeration of the lungs in consequence of dusty employment and sedentary habits, may not some harmless saprophyte be converted into the parasite which Koch has found to be associated with consumption?

After this explanation, which will, it may be hoped, enable the non-scientific reader to understand the problems presented for examination, and to realise their extremely interesting nature, the

points presented in Klein's paper may be very briefly stated. Firstly, contrary to what has been stated by some correspondents, Klein does not in his paper record a single experiment performed by him upon sheep; and he expressly declares that "the fact of his (Pasteur's) success in producing what he calls a 'vaccine'—a something which, when inoculated into sheep, produces some modified form of splenic fever (anthrax) that protects the sheep against the after-production of fatal splenic fever when the virulent material is inoculated into the sheep—may be taken as established." But with this admission Klein records results obtained by himself which are apparently not in harmony with the general hypotheses which Pasteur and others have promulgated. These results, moreover, have a further peculiar interest of their own. Klein complains that Pasteur has not made known the precise details of the process by which he produces the anthrax vaccine, and states that he himself has not been able to discover that process. His own inoculation experiments have been performed on rodents—mice, guinea-pigs, and rabbits—and, as we have said, they have been mainly designed to throw light on the hypothesis of the mutual convertibility of saprophytes and parasites as represented by the harmless hay bacillus and the deadly anthrax bacillus. Klein's experiments with rodents induce him to contradict, so far at least as the anthrax bacillus is concerned, the statements that (1) the oxygen of the air is the cause of the decrease of virulence, (2) that the cultivated bacillus does not form spores at a temperature of 42 to 43 deg. Centigrade, and (3) that the attenuated virulence once obtained is transmitted to the cultivation derived from that attenuated form. The last statement of course obviously bears directly upon the alleged possibility of artificially converting into each other the known harmless and deadly species. We need not describe in detail the modes of cultivation adopted by Klein; it will be sufficient to record the very remarkable phenomena observed by him. He grew the bacilli in gelatine pork and in pork broth. If grown in shallow vessels near the surface of the material and therefore in proximity to the air in the vessels, they formed spores; if grown at the bottom of deeper vessels in the same material no spores were formed until the rods, in growing upwards, reached the surface, when spores began to appear on the superficial rods. Hence the presence of free oxygen is apparently necessary to spore formation.

Klein further asserts that no spores are formed by the bacilli when in the bodies of animals. Now mice are peculiarly susceptible to anthrax; but Klein finds that, taking a given and perfectly pure cultivation of the anthrax bacillus, such a cultivation becomes decreasingly fatal to mice if prevented from forming spores by the absence of oxygen. It, however, exercises no protective influence

on mice. Thus, mice inoculated with a given cultivation which had not formed spores remained perfectly well; but if the same cultivation was allowed to grow to the surface of the gelatine, or broth, and there to form spores, inoculation with it after such spore formation killed the same mice with typical anthrax. The presence of oxygen in sufficient quantities would, therefore, apparently enable the cultivation to maintain its full virulence against mice for an indefinite period. But, strange to say, the same cultivation at any stage, whether spores were formed or not, produced typical anthrax in guinea-pigs and rabbits, and killed them within 48 hours. Briefly, Klein's conclusions are as follows:—Mice are insusceptible to the *Bacillus anthracis*, when cultivated artificially, after the cultivation has been kept for some time, provided no spores are formed; but such cultivation in minimal doses is fatal to guinea-pigs and rabbits. As regards the alleged cases of actual transformation of *Bacillus anthracis* into *Bacillus subtilis*, Klein is disposed to think that sufficient care has not been taken to exclude germs of the latter, and that the alleged transformations have been simply cases of the survival of the fittest, the anthrax bacilli being all killed off by the abundant growth of the hay bacilli.

The curious difference in the effects produced by the same virus upon different species of rodents, thus apparently demonstrated by Klein, cannot fail to give rise to much speculation and further inquiry. It shows that mice possess in this respect some peculiarity which is not possessed by guinea-pigs and rabbits, and it also indicates that artificially cultivated bacilli undergo some peculiar change as the period of incubation advances. With reference to the first of these conditions Klein points out that Algerian sheep are said to be altogether proof against anthrax, and therefore possess some peculiarity not found in French sheep. We may add that it seems to bear also upon the different degrees of resistance of various varieties of potatoes to the potato disease, and that it also calls to mind the mysterious peculiarity produced in man and animals by protective vaccination itself. For the rest, the apparent contradictions between the researches of Klein, Pasteur, and other micro-biologists are full of value. It is behind such anomalies that the truth lies, and it is from efforts to reconcile such anomalies that all great discoveries have been evolved. Those who have familiarised themselves with Pasteur's work during the past twenty years will look forward with perfect confidence and great hope to his further statements of the subject.—*Manchester Guardian.*

OUR VERIFICATION DEPARTMENT.

EXPLANATIONS.—Columns *a* and *b* give the denomination of the objective as issued by the maker. The column *e* shows the actual distance between the upper surface of the covering glass and the front of the objective, when used over a slide of *Amphipleura pellucida*, the frustules being mounted dry, on a cover suitable for observation with a one-twenty-fifth dry objective, and used in a ten inch tube. The column *d* gives the actual focal length of the objective determined by Cross' formula $\frac{n\,l}{(n+1)^2}$ where l = the distance between the two micrometers and n = the amplification at this distance.

The eyepiece used in a Ross A, with a diaphragm aperture of 0.75 inch, and yielding approximately an amplification of 5 diameters.

Column *e* contains the results of the aperture measurements by Professor Abbe's Apertometer; they are the mean of several, but the individual measurements scarcely differ from each other. Column *f* is calculated from the numbers in column *e*.

REGISTER NUMBER.	SOLD AS				REAL APERTURE.		REMARKS.
	a Inch.	*b* Air-angle or Aperture.	*c* Working Distance.	*d* $\frac{n\,l}{(n+1)^2}$	*e* Numerical.	*f* Air-angle.	
Number 115.....	1/4	... ...	0.13	.20	.30	36°	
„ 116.....	1/10	140°	0.015	.089	.80	106°	
„ 117.....	1/12	... ...	0.015	1/13	1.16		Above 180° in air.
„ 118.....	1/4	90°	0.03	.23	.65	81°	
„ 119.....	1/8	140°	0.01	.098	.86	120°	
„ 120.....	1/8	... ...	0.04	.089	.76	98°	Water immersion.
„ 121.....	2/3	... ...	0.28	.45	.23	27°	
„ 122.....	1/4	90°	0.025	.21	.73	94°	
„ 123.....	1/5	... ...	0.01	.18	.60	74°	
„ 124.....	1″	... ...	0.37	.82	.24	28°	
„ 125.....	1/2″	... ...	0.22	.51	.32	38°	
„ 126.....	1/4″	... ...	0.05	.29	.58	70°	
„ 127.....	1/8	... ...	0.03	.14	.80	106°	
„ 128.....	1/10	... ...	0.01	.098	.92	133°	
„ 129.....	4/10	... ...	... ...	... ...	.76	100°	Ach. condenser.
„ 130.....	1/4	100°	0.02	.20	.79	106°	

TESTING AIR, WATER, AND EARTH, FOR IMPURITIES.

IN his paper on the above subject, read at the Berlin Medical Congress, Dr. Koch remarked that at one period the three "elements" named were considered as capable of transmitting infection, without any exact theories being perfected as to their physical and chemical relations. With respect to air, he referred at some length to the process of filtration through gun cotton, and to the system of conducting (by means of an exhausting apparatus and supplementary appliances) a certain quantity of air to a plate of glass which was afterwards subjected to microscopic examination. Another form of test was that of bringing a current of air through so-called "nourishing fluids" in which the spores were developed. The subject of the various forms of "nourishing grounds" formed an important portion of Dr. Koch's paper, and detailed reference was made by him to the method adopted by Hesse for defining the exact quantity of air from which the spores originated, the development of which forms an important part of Dr. Koch's experimental method. A glass tube, about 12in. long and 2⅜in. wide, is closed at each end with india rubber coverings, in one of which a glass pipe is inserted, while in the middle of the other is an opening about three-eighths of an inch in diameter. Gelatine is placed along the bottom of the tube, which is in a horizontal position. The smaller pipe is then placed in connection with an exhausting apparatus, and a given quantity of air is forced through, the bacteria and bacteria-spores falling on the gelatine, which is described as being covered most thickly with them in the vicinity of the place where the air enters, while the opposite end of the tube is usually free from them. The quantity of air usually tested is said to be about twelve to fifteen litres. It is remarked that this process is a decided improvement upon the older method of assuming the quantity of carbonic acid in the air as being a measure of its impurity. According to the newer theory, air may be comparatively free from carbonic acid and still contain many noxious germs, while, on the other hand, air containing an excess of that acid may have but few of these germs. They are, however, found in relatively abundant quantity when there is dust in the air. The tests for water and earth are described as being carried out on the same principle, but with the necessary modifications. In the former case the gelatine is rendered fluid by heat, and the required quantity is introduced into a test-tube of moderate size, a drop of the water to be examined being added, and the opening closed with wadding. After two or three days the bacteria can be dis-

tinguished. By this system of testing, one drop of water from the Spree has been found to contain 1000 germs, which filtration seems unable to remove. In testing earth, it can be strewed over a glass plate on which gelatine has previously be placed. The value of these processes will, it is considered, be much appreciated in testing the action and value of various disinfectants.—*Lancet.*

PRACTICAL PROCESSES IN VEGETABLE HISTOLOGY.*

By L. Oliver, in Rev. Sci. Nat., 1882.

Taken from the Journal of the Royal Microscopical Society.

IN studying the structure of a living organism it is not sufficient to examine under the Microscope the form and relations of its elements. We must, in addition, determine the chemical nature of each. In this physiology is as much concerned as general anatomy, physiological functions being the resultant not merely of the molecular composition, but also of the arrangement of the organic structures.

The endeavour has, therefore, been to find for histology reagents capable of discovering in the interior of the cells the presence of the analysed substances.

Two methods have been adopted. The older and more general consists in examining, under the Microscope, different preparations of the same organ, before and after the successive action of certain agents on it. Note is taken of what this complex treatment eliminates, precipitates, or colours. This result is compared with that obtained by a different treatment of the same organ, or by the similar treatment of a different organ, thence deducing the characters of the tissues experimented on. Thus pieces of wood, in which the Microscope reveals the existence of cells, vessels, and fibres, no longer show cells after being subjected to the influence of certain substances. Another series of reagents causes them to lose their fibres without destroying their vessels, whilst the former resist the treatment which dissolves the walls of the vessels.

It is to this kind of analysis that we have been so long limited. The increasing perfection of practical microscopy now enables us to substitute for it a more certain and productive method, that of micro-chemical reactions.

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* Rev. Sci. Nat., i. (1882) pp. 436-54; ii. (1882) pp. 71-91.

When an organ is acted upon by a whole series of acids, bases, or salts, and then examined under the Microscope, it is difficult to disturb clearly the histological elements, and still more to pronounce upon the nature of the changes to which a given treatment has subjected them. Given several kind of elements, it is impossible to decide what action they may exercise one upon the other in a mixture. Besides, all the elements being more or less disintegrated by the chemical treatment, we are rarely in a position to pronounce upon the histological nature of those which have not been completely dissolved. If, on the contrary, they are all observed in *the same preparation*, in a thin section where they are only juxtaposed, all the phases of the reaction can be followed under the Microscope, and there is no longer any risk of being mistaken as to the localisation of the phenomena.

In animal histology this method is already very advanced. In vegetable histology it is still very rudimentary, the sparse data which science possesses on the matter not having been yet collected into a systematic method in botanical treatises.*

Let us first call attention to the fact that the same reagent does not always produce identical modifications in all those elements whose fundamental composition is the same. In order to produce the same effects in all the organs in which the elements are found it must often be employed in *different degrees of concentration.* Sometimes even its action must be preceded by that of another agent, which eliminates from the element to be discovered the substances masking the phenomena. It is therefore important to note, in the case of the majority of the reactions which will be indicated, in which special cases they have given good results.

The operator ought not, moreover, to be content with a single reaction, *the accuracy of a determination resting entirely on the concordance of numerous observations.* Hence the many series of manipulations intended to render the preparations transparent, to fix the microscopical forms, to contract the structures, to precipitate or dissolve certain substances, and to colour and finally to preserve them.

I. Clarification.

1. Generally the tissues are made transparent at the same time that thin sections are prepared. For this purpose recourse is had to the alkalies (ammonia or potash), to glycerin, and to chromic, acetic, carbolic, and nitric acids.

* V. A. Poulsen published at Copenhagen a very excellent little book on this subject, translated into German ('Botanische Microchemie,' Cassel, 1881) by C. Müller, from which, as will be seen, we shall borrow largely.

Ammonia. — Professor Dippel * uses ammonia to give transparency to delicate sections of plants whose tissues would be lacerated by too long immersion in concentrated alkali. The ammoniacal gas, being rapidly disengaged in the open air, the action which it exercises on the tissues in an evaporating dish is weakened in proportion to the thinness of the sections.

Potash.—This substance is of more general use than ammonia. It especially thins cell-walls of cellulose membranes. Poulsen,† Nägeli,‡ Dippel,§ Wiesner,‖ and Sachs¶ have tried it in very different researches, and are unanimous in recommending its use for thinning the cell-walls, and making them clearer.

In a weak solution it also renders protoplasm transparent.

It is dissolved in water or alcohol.

The solution is made to act either on the preparations themselves or upon the organs before they are cut. In this case the alcoholic solution is the best. Russow** has made a good preparation of it by pouring into alcohol of 85 or 90 per cent. a concentrated aqueous solution of potash in such quantity that after twenty-four hours there will be a deposit at the bottom of the vessel. It is then sufficient to decant the liquor to obtain it in the requisite condition.

Hanstein†† has made use of it to study the root-cap and the embryo. Sections of stems, leaves, or roots immersed in it acquire great distinctness. Hanstein leaves them in it for several hours, then washes them in very dilute hydrochloric acid or weak acetic acid, so as to neutralise the alkali. Sometimes the latter treatment darkens the cells; the preparations are then exposed to the action of ammonia, and washed in distilled water before placing them in glycerin, which further clears them.

Glycerin.—This liquid only clears thin objects preserved in it *after a considerable time.* This property is strengthened by the addition of acetic acid to the glycerin.

(To be continued.)

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* 'Das Mikrosop,' i. (1867) p. 279.

† Loc. cit.

‡ 'Das Mikrosop," 1877, p. 472 and 525.

§ 'Das Mikrosop," i. (1867) p. 278.

‖ 'Tenische Mikroskopie," 1867, passim.

¶ "Ueber die Stoffe welche das Material der Zellhäute liefern," in Pringsh. Jahrb., iii. 1863.

** Mém. Acad. St. Petersburg, xix. p. 15.

†† "Die Entwickelung des Keimes der Monocotyl. und Dicotyl." in Hanstein's Bot. Abhandl., Bonn, 1870.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

MICROSCOPICAL LABELS.—In our last issue we noticed some labels for micro-objects, sent us by Mr. Quinn. A Liverpool correspondent calls our attention to the fact that Mr. I. C. Thompson first devised similar labels which were mentioned on page 206 of this year's volume, sending us at the same time specimens of

VEGETABLE KINGDOM		Part .....
Sub Kgdm		.....
Class.....		Medium .....
Order		.....
Fam		Presenter .....
Gen		Mounter.....
Sp		MICROSCOPICAL
.....		SOCIETY OF LIVERPOOL.

MR. I. C. THOMPSON'S LABELS.

ANATOMICAL PR^{N}		Tissue .....
Sub K.....		.....
Class		Stain .....
Order		Medium .....
Fam.....		Mounter.....
Gen		.....
Sp.....		
.....		

MR. QUINN'S LABELS.

those labels. We are sorry some specimens of these labels were not sent with the abstract of the Liverpool Proceedings, for until we received Mr. Quinn's, we were not aware that such labels could be purchased.

These new labels are placed upon the slide as indicated in the figure, which conduces to their being placed always "the right side up" on the stage of the microscope.

QUI CAPIT ILLE FACIT.—The Editor of the Journal of the Postal Microscopical Society charges "a contemporary" with publishing a "somewhat mutilated copy" of Mr. Moore's paper, *Organisms from the recently discovered Roman bath.* As the cap nearly fits us, we are contented to wear it, and beg to inform the microscopists of Bath and elsewhere that we shall always be glad to publish articles of value at early dates, which have been "pressed out for want of room" from other Journals in order to admit articles of less value.

With regard to the charge of "mutilation," we refer our readers to the two articles, when we feel sure they will consider the charge non-proven.

OSTEOLOGICAL SPECIMENS.—Mr. E. Wade Wilton, of Leeds, has sent us the skeleton of a frog, such as he prepares for the use of students in Biology. Two series are supplied; the cheaper one is permanently fixed to the card, whilst in the other each separate bone can be detached for examination. The price to teachers is 38s. and 30s. per dozen.

PRACTICAL BIOLOGY CLASSES.—The Manchester School Board have made arrangements to hold Classes during the evening Science Session (October to May) in Practical Botany and Practical Biology.

In the Practical Botany Class Students will have the opportunity of studying the Structure and Classification of Plants by the examination of fresh specimens. For this purpose the necessary apparatus and materials will be provided.

The Practical Biology Course will be that of Huxley and Martin, and will include the Life History and Structure of the following Plants and Animals:—Yeast, Protococcus, Chara, Fern, Flowering Plant, Bacteria, Amœba, Paramœcium, Vorticella, Hydra, Lobster, Freshwater Mussel, and Frog.

The Biology Course will be a great help to students of Botany and Physiology, and to those preparing for the B. Sc. and other Examinations, and will be especially invaluable to those possessing Microscopes, as the Course embraces practical instruction in the preparation, staining, and mounting of microscopic tissues and organisms.

HYDRA.—The conclusion of Mr. Dunkerley's paper on Hydra is unavoidably postponed until our next.

COLE'S STUDIES.—We are very glad to notice that the celebrated "Studies in Microscopical Science," have been again resumed. No. 4 contains a dissertation on the cell theory, illustrated with two beautiful plates.

The third part of "The Methods of Microscopical Research" has also been issued, so that we hope Mr. Cole has surmounted all his difficulties.

NOTE ON THE SECTIONS OF PINNULARIA.—We have been favoured with a *brochure* from Mr. Prinz on the above subject, alluding specially to Mr. Burgess' paper in our March number. A translation of this paper will appear in our next.

ERRATA.

Page 275, line 17, for "by their" read for their.
Page 277, line 16, for "quatnox" read quatuor.
Page 278, line 7, for "short-hooked" read short, hooked.

THE MICROSCOPICAL NEWS

AND

NORTHERN MICROSCOPIST.

No. 36. *DECEMBER.* 1883.

HYDRA: ITS ANATOMY AND DEVELOPMENT.

BY J. W. DUNKERLEY, F.R.M.S.

(Continued from page 273.)

IT may be here observed that some writers state that you may slit the animal up and lay it out flat like a membrane, etc., etc., with impunity, and then very considerately tell us that we need not try the same experiments, as they have been demonstrated and confirmed.

My intention to-night is to give the results of a few of my experiments. I have already mentioned to you the success I have had in dividing Hydræ, which I will now try to demonstrate a little more fully in detail by means of diagrams and prepared specimens. But before doing so, allow me to tell you what experiments have proved to be entire failures on my part in reproducing perfect specimens.

1st. Tearing Hydra into minute parts.

2nd. Crushing Hydra into a pulp.

3rd. Engrafting the head of one upon the head of another.

4th. Making two become one perfect animal.

5th. The cutting of Hydra into forty pieces did not produce one single specimen.

These experiments were all tried at the best season of the year, and at the same time I was having very good results from the simple division of the polypes, which you will perceive by the following taken from my notes :—

On June the 3rd, 1881, at 2-20 p.m., I took *H. vulgaris*, which had been well fed, out of the tank, wherein were a number of other fine specimens. It was then placed upon a piece of cardboard in a drop of water, and when in the contracted state, it was cut with a fine scalpel through the mouth and body, but not through the foot or disk.

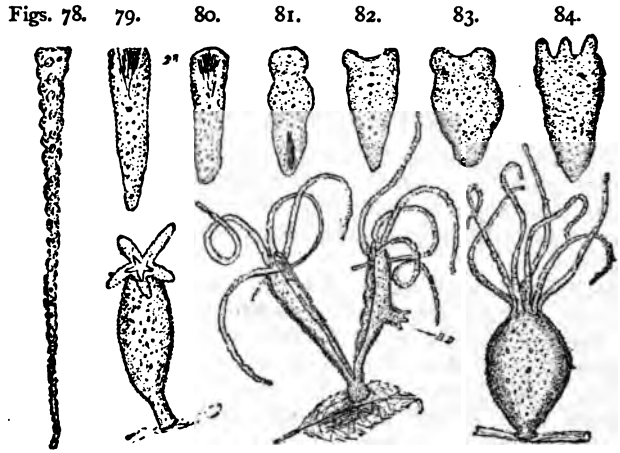
I succeeded in dividing it into two equal parts, except that I

severed a tentacle (Fig. 78) from the head of one part, placing these very carefully in a watch glass which acted as a tank, that I might observe them the more easily under the microscope.

Great was my surprise to find the tentacle which had been cut off holding on to *Cyclops quadricornis*, which struggled hard to make its escape, but was powerless to do so, the tentacle being carried about by the water-flea; a short time afterwards poor Cyclops was dead.

This, I believe, is one of the clearest proofs of the stinging power of the Hydra.

The cut portions, one hour after division, were simply curled up,



or twisted upon themselves, and lay upon the bottom of the glass for three hours, no movement either of the body or tentacles being observed. The tentacle, however, which had been severed had made more progress.

At first it simply contracted and expanded very slowly, and in one hour I could discern that in the expansion it was considerably shorter and thicker than before. I also noticed that it contained the protoplasmic fluid, the corpuscles floating about in it, and that it was much darker at the base or severed end. In one hour and twenty-five minutes it had assumed the shape seen in Fig. 79, the upper part representing the base, and the lower the free end of the tentacle.

In twelve hours it was very much shorter and thicker at the lower part, and was perfectly healed at the upper portion, or what was formerly the attached end. (See Fig. 80.)

From this time a greater change took place; the portion which formerly was the free end of the tentacle became very much swollen and rounded. I also discerned three distinct parts forming. (Fig. 81.) And after careful watching, I found that the free end of the tentacle became larger and larger, and that the lower portion became narrower, and eventually formed foot; the free end of the tentacle at the same time forming the future head.

This was observed in twenty-four hours after severance, as represented in Fig. 81. Thus, you see, what was formerly the upper part in Fig. 80 is now the lower part in Fig. 81.

In forty-eight hours, as represented in Fig. 82, the tentacle was shaped like a minute Hydra, without tentacles; the body was well-defined and properly upright, having fastened itself by the lower part (which I now call the foot) firmly to the glass.

On the upper surface two minute processes could be seen; and for some time after this it continued to develop in bulk, except the processes last mentioned.

In seventy-two hours, by Fig. 83 it will be seen that it had increased in size nearly double what it was as represented in the preceding figure. For three days no change could be observed; but on the seventh day three distinct processes could be plainly seen, which developed into tentacles. (Fig. 84.) On the tenth day five tentacles were seen without the aid of a glass. (See Fig. 85.) The body had lengthened itself, and the foot-stalk was easily made out with the aid of a lens.

It continued to develop, and on the fifteenth day (Fig. 86) it had seven tentacles, and the body, when in the contracted state, was very much larger than the polype of which it had previously formed a part. Up to this time it had not partaken of any food, but now its arms began to play freely, and, for the first time, it caught *Daphnia pulex*, and in two hours I noticed that it partook of food. The polype, now a perfect Hydra, having taken fifteen days from the time of division to that of perfection.

This experiment I have repeated on several occasions this year.

We will now turn our attention to the Hydra of which the tentacle had formed a part (Fig. 87), and which had been divided through the mouth and body.

For three hours it lay curled up at the bottom of the glass. During the following hour the cut parts extended themselves, and the foot attached itself to a leaf. The parts at the outer edge were very dark in colour, some of which sloughed away. In five hours after division these dark spots could no longer be seen. The tentacles began to move freely in the water, and at the posterior end of the cut portions, the outer edges were slightly rounded, and evidently being drawn together.

In twenty-four hours it was still in the same state.

In forty-eight hours the cut parts were gradually healing upwards by the outer edges being drawn together.

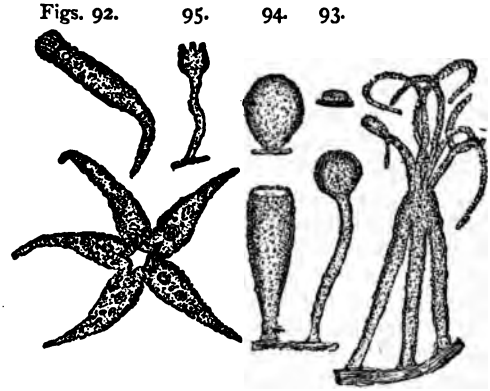
This was finally completed in three days and six hours, so that now I have two perfect bodies from the original Hydra upon one foot-stalk, each body having four tentacles.

The next day I could discern on one of the bodies a slight swelling, which in four more days turned out to be a young bud; three processes showing themselves at this time. (Fig. 87 B.D.)

The young Hydra was the first to partake of any food; after this time the parent caught and devoured its prey, and both of the cut portions continued to bud freely.

I find that it is perfectly true that Hydræ which have been divided grow much larger, and bud more freely than those not operated upon.

Figs. 92. 95. 94. 93.



Figs. 88. 89. 90. 91.

Experiment third. I cut a polype into two parts transversely, as close as possible to the part where the arms branch out, giving to the head part the appearance of a five-fingered star-fish. (Fig. 88.)

In the centre the mouth could be very well defined, and it is in this state that its position and shape can be best made out. The mouth extends and is somewhat drawn into the arms. Upon placing it into fresh water in the glass, the head part lay upon the bottom for some time. The arms, by constantly contracting and expanding, gave evident signs of life.

In twenty-four hours it had drawn the opening together, and had, at the same time, lengthened its body, although but slightly, giving it still more the appearance of a star-fish; for it not only rested upon its arms, but moved from place to place by stretching them out and drawing its body forwards. In forty-eight hours it

had produced a body of about one-twentieth of an inch in length, and appeared like a minute Hydra with arms too big for its small body. In fifty-two hours it had secured a firm hold upon the glass, and stood perfectly upright, the body growing longer; so that in seventy-two hours the head portion appeared but little different from what it was before severance, except in size. In ninety-six hours after division, the new body produced by the head part constantly expanded and contracted, and was then complete. No food was partaken of until the ninth day, and at that time several buds made their appearance.

The body (Fig. 89) which had been separated from the head lay extended for one hour. At the severed end it remained swollen, the lower part gradually became thinner, and in this state it remained for twenty-four hours. After this time, the upper portion assumed the shape of a perfectly round ball, with a long and thin foot-stalk, as represented in Fig. 90. The foot was firmly attached to the glass, and it remained in this state for the next forty-eight hours, waving to and fro its club-like head.

The first perceptible change was a small protuberance about the centre of the foot-stalk; and during the fourth day, this enlarged to such an extent that it was apparent that a young polype would form before the upper portion produced a new head, and this turned out to be the fact.

On the fifth day it lay on the bottom of the tank, fully extended. The young bud had grown considerably, and four minute arms were perceptible. The upper portion of what I now call the parent without the head, had still a rounded or ball-like appearance.

On the seventh day, the young polype had so much grown, that it was able to catch its prey, and so helped to feed not only itself, but also its parent; on the following day, the whole body was much larger, and at the anterior end, upon the ball-shaped mass, three minute arms were discernible, so that it had acquired a head. The body also began to swell out, and increased in size very much during the next twenty-four hours; and another bud began to make its appearance. On the tenth day, the new head had six short arms.

The bud No. 1 caught food freely, and bud No. 2 grew very quickly,—the whole organism becoming very strong and healthy. In two more days bud No. 1 commenced life on its own account, and the remaining bud had at this time five arms. The arms, also, around the new head were fully grown, and played freely in the water, but I did not observe them catch any food. The Hydra now was exactly like any other; so much so, that no person would imagine it had once formed only a part of one.

One thing noticed on several occasions was, that when Hydra

was divided, the tentacles budded or branched out in one or two places on the same arm, giving that arm a forked appearance. Fig. 91 represents a Hydra which was divided through the foot and body into three parts, but not through the head. It remained in this state after the cut parts had healed, for eight weeks, budding freely from each foot-stalk, and, finally, separating two of the foot-stalks from the body, by the strongest part pulling itself away from the Hydra.

The parts thus severed produced a new head.

Fig. 92 represents a single tentacle with a small portion of the head attached. I have already described the growth of a single tentacle with no part of the body attached to it, and shown that it produced a perfect Hydra. But the tentacle now under consideration had nothing to do with the formation of the new body. The tentacle retained its full length, the body being formed by the small portion of the head attached.

On the sixth day two new tentacles could be seen, and on the eighth day two more tentacles protruded. On the tenth day the new body was perfect, though small in comparison to the large tentacle. In two more days the new tentacles were fully grown, and also the new body.

The last experiment performed was one I have never seen mentioned; and that is the severance of the disk or sucker from a full-grown Hydra.

Fig. 93. This is really to me one of the strangest of sights. The transformation from a flat piece of protoplasm to a full grown and perfect Hydra is really wonderful. I first observed the flat piece or mass, blown out like a balloon (Fig. 94), the lower part adhering to the glass, beautifully transparent, so that I could see quite through its thin walls. No opening was observed, proving at once that it had no anal canal. No contraction took place, and it remained for three days exactly in the same shape.

On the fourth day, it began to contract at the base, so that on the following day, the anterior end assumed the ball-shape and thin foot-stalk exactly as Fig. 89, only much smaller. For two more days there was no change.

On the eighth day, three minute processes appeared (Fig. 95), but their growth was very slow and irregular. The body also began to enlarge, and continued to do so for the two following days.

On the eleventh day, the three tentacles were half the length of a full-grown polype, and two other arms also began to shew themselves; also, a small protuberance was observed, which in turn formed a young polype. The young one first caught its food, as before observed.

In seventeen days from the time of division, it was a perfect and full-grown Hydra, with the young still attached.

I have tried to repeat this experiment during September and October, but have failed to do so on account of the cold.

In conclusion, I wish to state what I have observed since the first part of this paper has appeared in print.

On three separate occasions I have noticed a very large Hydra, entirely covered with sperm sacs; and surrounding this polype were several others with ovaries only, no sperm sacs being visible. The bursting of the ovaries occurred at the same time in all the Hydræ. In some cases two eggs were produced, and at the same time the Hydra covered with the sperm sacs poured out the spermatozoa in abundance; and this continued for six hours. The eggs remained attached to the Hydra for three days, when, finally, they dropped off and fell to the bottom of the tank.

PRACTICAL PROCESSES IN VEGETABLE HISTOLOGY.

By L. Oliver, in Rev. Sci. Nat., 1882.

Taken from the Journal of the Royal Microscopical Society.

(Concluded from page 322.)

Acetic acid.—The effect of this acid is very perceptible when care is taken to wash the preparations in distilled water before submitting them to its action. It assists the examination of the nuclei, which it renders more visible, chiefly by effect of contrast, rendering the protoplasm which surrounds them soluble in the water.

Carbolic acid.— E. Warming, whose interesting work on bacteria and monads is well known, has found in carbolic acid a valuable agent for rendering these little organisms transparent.

Alcohol and Nitric acid.—We have obtained preparations of *extreme thinness and of the greatest transparency** in the following manner:—Place in a watch-glass the objects to be thinned (sections of stems or roots); add to them alcohol of 36°, into which pour, drop by drop, concentrated nitric acid until the red vapours of hyponitric acid are disengaged. If the preparations are violently attacked, cover the watch-glass with a small bell-glass, observing through it what takes place in the liquid; as soon as the preparations rise to the surface of the mixture raise the cover, and by means of two *wooden* needles push them to the bottom of the glass.

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* 'Recherches sur l'appareil tégumentaire des racines' (8 pls. and 50 micro-photographs). Paris, 1881.

When there is no disengagement of red vapour at the normal temperature, set fire to the alcohol in order to concentrate it further, and warm the watch-glass on a piece of wire-gauze over a gas-burner or spirit lamp.

Under these conditions the cell-walls undergo a considerable thinning, but all their contents disappear. They become so delicate that the difficulty is to remove them from the water in the evaporating dish (into which the watch-glass has been emptied) to transfer them into the glycerin of the slide. We attain this object by adding to the still warm alcohol a little chloroform; this treatment hardens the preparations, which can then be transferred by means of little *wooden* spatula into the glycerin, where they soon recover the same flexibility as in the watch-glass.

We have obtained better photographs of vegetable sections thus prepared than with those obtained by other processes.

Chromic acid.—According to Hohnel † this acid gives transparency to tissues of a corky nature, such as cells of cork, epidermis, cuticles, and the envelopes of pollen-grains, to the extent of making details perfectly visible, which, without the aid of reagents, could not have been seen.

The solution of chromic acid admits of very different degrees of concentration, the important point being that it should be free from sulphuric acid.

Calcium chloride.—When it is desired to give transparency to the preparation without thinning it, it may be very useful, especially if the tissues are young, to have recourse to the process employed by Treub, ‡ and afterwards by Flahaut, § which consists, as described by the latter author, "in placing the sections in a watch-glass or in a small porcelain capsule with one or two drops of water; the drop is covered with a little dry calcium chloride in powder, and slowly warmed over a small flame until the desiccation is nearly complete. The sections are withdrawn directly from the action of the flame, and a few drops of water added, which dissolve the calcium chloride. The sections immediately float in the water; they need only be collected and placed in the glycerin, in which they attain sufficient transparency after a few hours. This treatment results, not in dissolving all that the cells contain, but in darkening their contents by slightly thickening the originally very thin walls; these walls become at the same time clear and brilliant. The opacity of the cell-contents obstructs the study of several layers of cells at the same time.

† "Ueber Kork," SB. Wiener Akad., 1877, 1 Abth.

‡ 'Le méristème primitif de la racine des monocotylédones.' Leyde, 1876.

§ "Recherches sur l'accroissement terminal de la racine chez les Phanérogames," Ann. Sci. Nat., vi. (1878) p. 24.

ON SOME EXPERIMENTS MADE WITH A VIEW OF KILLING HYDROID ZOOPHYTES AND POLYZOA, WITH THE TENTACLES EXTENDED.

By Herbert C. Chadwick, F.R.M.S.

SOME time ago, having heard that Marine and Fresh-water Polyzoa had been successfully killed with the tentacles fully extended, by means of a one per cent. solution of osmic acid, I determined to try the experiment myself. The subjects of my first experiments, all of which resulted in a complete failure, were a few specimens of *Lophopus crystallinus*.

Shortly after this, a slide was shown to me, on which was mounted a specimen of *Bugula plumosa*, which had been killed with osmic acid. The tentacles, though almost fully extended, were much blackened by the acid, and did not show much of the effects of the picro-carmine stain to which they had been subjected. The slide was, therefore, of little scientific value.

About the same time I subjected a small specimen of the same species to further experiment, using absolute alcohol instead of osmic acid. The result was a most encouraging success. I then experimented with alcohol upon *Lophopus crystallinus*, and the result was several most successful preparations. Further experiments upon *Bugula plumosa* gave various results; in some cases complete success, in others failure.

Bugula flabellata was very difficult to deal with, but after half-a-dozen attempts, I succeeded in killing a specimen which was shown, stained and mounted, at the October meeting of the Manchester Microscopical Society. The method employed in every experiment is as follows:—Place a specimen of the Polyzoon to be experimented upon in a small beaker or clear glass bottle, and allow it to remain at rest for several hours. Now take a dipping tube drawn out to a very fine point, and charge it with absolute alcohol. Having ascertained by means of a pocket lens that the polypides are fully extended, allow the alcohol to drop very gently from the point of the tube, which should be held just above the surface of the water. The success of the experiment depends largely upon the care with which the first quantity of alcohol is introduced into the water. After the lapse of an hour, if the polypides are still extended, a further quantity of alcohol may be added, until the quantity reaches 60 per cent.

After passing through 75 per cent. alcohol, the specimens may be kept in 90 per cent. of the same, until required for mounting. Experiments with alcohol upon Hydroid Zoophytes were not so successful, but Kleinenberg's Picrosulphuric acid solution, with

which I experimented recently, gave excellent results. It is pre-prepared as follows :—

Picric acid (cold saturated solution in distilled water) 100 volumes
Sulphuric acid (concentrated) ... ... 2 „

Filter the mixture, and dilute it with three times its bulk of water. The use of this reagent is attended with much less difficulty than that of alcohol. If the subject of the experiment is a Zoophyte, such as *Aglaophenia pluma* or *Plumularia setacea*, it must be allowed to remain some hours until the polypides are fully extended. Kleinenberg's Fluid must then be introduced by means of a dipping tube. It may be allowed to flow over the specimens in a continuous stream, until the whole of the water assumes a golden yellow colour. The reagent causes instant death, so that the specimens may be transferred immediately to 60 per cent., and afterwards to 75 per cent. alcohol, allowing them to remain in each solution for some hours. Keep in 90 per cent. alcohol. From four to six minutes immersion in Martindale's Picro-carmine Staining Fluid is sufficient to stain specimens killed by either of the above methods.

To the Editor of "The Microscopical News."

DEAR SIR,—My attention has been called to a paragraph in the last number of your Journal, referring to a note in the previous number wherein you appear to have given credit to a Mr. Quinn for bringing out some Micro. Labels, while in the last number you divide the credit between Mr. Quinn and myself.

It would certainly appear a rather curious coincidence that two people should separately bring out a set of labels precisely similar both as to special colours and matter of each, and at precisely the same time; and before giving a sketch of each I think you might with advantage have ascertained whether they had not one common origin. To convince our readers that such is the case I can only refer to Mr. Wilkinson, of Pendleton Printing Works, to whom I handed all my original sketches of the labels—three being for myself, and two for the Microscopical Society of which I am Hon. Secretary.

Upon enquiry I find that Mr. Quinn saw these labels while in the printer's hands, and that he at once procured almost exactly similar ones, and of the same colours, and I am rather surprised that he should not, through your columns, have corrected your error.

I would gladly have sent you copies of these labels at first, but that a full abstract of my *explanatory* paper, entitled "On the Classification and Labelling of Microscopical Objects," was sent to another paper, where it appears in the present month's issue.

Herewith I append specimens of these labels :—

ANIMAL KINGDOM	
Sub Kgdm	Part .....
Class.....	.....
Order	Medium .....
Fam	.....
Gen	Mounter.....
Sp	Date.....O.G.....
....	I. C. THOMPSON, L'POOL.

VEGETABLE KINGDOM	
Sub Kgdm	Part .....
Class	.....
Order	Medium .....
Fam	.....
Gen	Mounter .....
Sp.....	Date.....O.G.....
.....	I. C. THOMPSON, L'POOL.

MINERAL KINGDOM.	
.....	Object .....
Era.....	.....
Formn	.....
Descriptn.....	.....
....	.....
Locality	
.....	I. C. THOMPSON, L'POOL.

MINERAL KINGDOM.	
.....	Object .....
Era.....	.....
Formn	.....
Descriptn.....	.....
.....	Presenter .....
Locality	Mounter .....
.....	MICROSCOPICAL SOCIETY OF LIVERPOOL.

ANATOMICAL PREPN.	
Animal	System .....
Part	.....
Structures	Stain .....
.....	Medium .....
.....	Presenter .....
.....	Mounter.....
	MICROSCOPICAL SOCIETY OF LIVERPOOL.

And can only add that any one is now at liberty to use similar labels, or to improve upon them.—Yours faithfully,

ISAAC C. THOMPSON.

Woodstock, Waverley-road,
Liverpool, November 2, 1883.

FOOT AND MOUTH DISEASE.

THE rapid spread of foot-and-mouth disease has again called forth suggestions from all quarters. Professor Brown recommends carbolic acid and a solution of nitre; but it has been pointed out that while the latter could have little effect, the former is valuable chiefly for the feet, and even then if not thoroughly done it might not be effectual. By far the best suggestion is that of Mr. Frederick Wilkinson, of Sydenham, who, while advocating the use of tar, suggests that the farmer might utilise a small shed as a "prevention house." A gate should be on each side, and the floor asphalted. Upon this he suggests a covering of four inches of tar, through which the animals should be walked into the straw-yard twice a week, or more frequently if necessary. In the case of a large and valuable herd such an expedient might be of the greatest use. With regard to the mouth, he suggests the use of hyposulphite of soda. Of this, as it is almost tasteless, half an ounce should be put to every gallon of water, and given the cattle to drink. This would prevent the formation of aphthæ, and render the animals secure against zymotic attacks. While cattle are becoming infected in all parts of the country, and without any hope of a check, other serious cases arise in connection with the disease. In Norwich a large number of persons have been ill from drinking the milk of infected cows. Diarrhœa, burning in the throat, depression of spirits, and a species of delirium in the night were the symptoms. At a farm in Hertfordshire the owner lost a valuable cow, but although orders were given by the veterinary surgeon to prevent any portion of the flesh being eaten, some pigs got at it, and one quickly died, while the farmer was affected by the fumes of the carcase, and the butcher who handled it became seriously ill from blood poisoning, and is now in the hospital in a bad state, the virus having entered his system through a small abrasion in the hand. It must not be forgotten that the use of salicylic acid is still proving most valuable in cases of disease; it is most comforting for the mouth, and enables the worst affected animals to feed very quickly.

THE GERM THEORY OF DISEASE.

AT the meeting of the British Association, held at Southport in September last, Dr. Carpenter read a paper on the germ theory of disease. Notwithstanding the tendency among modern pathologists to regard the various forms of zymotic disease as distinct, he maintained that the application of the natural history method to the study of these diseases justified the belief that the same germs, undergoing development under different conditions, manifested themselves in a great variety of forms; that scarlatina, small-pox, and other diseases of this nature had acquired considerable fixity of type, yet that this fixity did not necessarily hold good over the whole world, or for all time. Inoculation for small-pox did this great good, that it cultivated a mild disease out of a severe one, as was proved during the plague in the middle of last century. A converse result was observed during the siege of Paris in 1870, when malignant small-pox developed from the mild form of the disease; the epidemic broke out violently in London, and extended over the whole kingdom. Further, he argued that malarial disease originating in germs bred in the soil was convertible into a distinct form of disease, into germs which bred in the human body, and could be communicated from one human body to another. The same doctrine held true in regard to typhus and typhoid fever—an opinion in which he was supported by the late Sir Robert Christison. Lately he had a controversy with Dr. Tyndall on this subject, Dr. Tyndall holding that cholera could only be propagated by germs from the human body. The speaker on the other hand maintained that the germs might be bred in collections of decomposing matter, sewers, heaps of filth, and marshes. This view was supported by the report just published by Surgeon-General Hunter on the recent epidemic of cholera in Egyyt. Dr. Hunter had completely disproved the theory that the disease had been imported from India, and shown that it had originated from the Egyptian marshes.

YELLOW FEVER.

DR. DOMINGOS FREIRE, of whose alleged discovery of the micro-coccus of yellow fever we gave an account some time ago, has, according to a communication from his own pen which appears in the Brazilian papers, already begun to "vaccinate" human beings resident in Brazil, in order to protect them against the dreaded South American scourge. It will be remembered that

Dr. Freire, having succeeded in isolating the micro-organism which is apparently peculiar to yellow fever, and having shown that with its aid he could produce yellow fever in rabbits and guinea pigs, "attenuated" its virulence by means of successive cultures in gelatine, and then found that animals inoculated with the attenuated forms exhibited febrile symptoms of a very mild character, and were subsequently proof against inoculations with unattenuated, and under ordinary conditions fatal, virus. Reasoning from these experiments to what would appear to be a logical conclusion, Dr. Freire has convinced himself that a method which protects animals will also protect the nobler species, and, what is more, he appears to have likewise convinced a Commission, consisting of seven Brazilian doctors, appointed by the Brazilian Government to verify his experiments. He has already "vaccinated" five persons with attenuated *Cryptococcus xanthogenicus* (the modest name of the small organism in question), and the Commission have authorised him to continue vaccinating a great number of persons. Of the five individuals vaccinated, two are French, one is Portuguese, one Brazilian, and the remaining one is English. None of them has ever had yellow fever, except the Brazilian, who had an attack eleven years ago. The symptoms resulting from the vaccination are buzzing in the ears, a slight rise of temperature after an interval of twenty-four hours, dull pains in the abdominal and lumbar regions, in short "the symptoms which characterise the so-called 'yellow sickness' which has been observed during yellow fever epidemics" in Martinique, at Gibraltar, in Brazil, and elsewhere. It is specially worthy of note that, of the five persons who have had the courage to submit to the operation (three punctures in the arm with a lancet previously dipped in a "culture" of the sixth generation), the solitary representative of Great Britain is a woman. She has been resident in Brazil for many years, a fact which may account for her indifference to the denunciations of "Pasteurism" by an eminent representative of the same sex in this country. As for the two Frenchmen they are new arrivals in Brazil, and therefore may be supposed to be under the influence of the enthusiasm lately manifested in France with regard to the discoverer of anthrax vaccination. Whether Dr. Freire's new departure is destined to inaugurate successive vaccinations against all the zymotic diseases remains to be seen. Should his method prove as effective in controlling yellow fever in Brazil as Jenner's discovery has proved in this country in controlling small-pox, a very remarkable result will have been attained. The idea of successive vaccinations with the specific microbes of a long series of epidemic diseases, however, calls to mind Mark Twain's apprehension with regard to patent medicines, that "they might go fooling about one's system curing something they were not intended to cure."—*Manchester Guardian.*

CLASSIFICATION OF THE UREDINES.

THE following letter appears in *Grevillea* for September last:—
The Editor has said more than once that controversies upon matters mycological lead to no good; and, believing him to be right, I will only say that I have read carefully his remarks on p. 151. During the past summer I have been working at the physiology of the Uredines, and although I do not intend here to give the details of my experiments, I wish to point out—

(1) That the teleutospores of *Uromyces poæ*, *Rbh.* which previously had not been met with in Britain, have been found abundantly this year on *Poæ trivialis* and *P. pratensis* wherever their grasses grow near Æcidium ficariæ.

(2) That the *Æcidium* upon *Ranunculus repens* is connected with *Uromyces poæ*, and not, as was stated in my paper, with *Uromyces dactylidis*.

(3) That *Æcidium rumicis* is connected with *Puccinia arundinacea*; and that the *Æcidium* has followed the infection with *Puccinia Arundinacea* spores upon *Rumex obtusifolius*, *crispus*, *hydrolapathrum* and *conglomeratus*, and upon the common rhubarb.

(4) That up to the present time sowing the spores of *P. arundinacea* and *P. Magnusiam* on *Rumex acetosa* has with me produced no Æcidium.

(5) That as no Puccinia occurs on gooseberry leaves in this country it is clear Æcidium grossulariæ, as we find it, is not a Pucciniopsis, but is probably a heterœcismal species.

CHARLES C. PLOWRIGHT.

7, King Street, King's Lynn,
Aug. 15, 1883.

NOTES AND QUERIES.

ALL Notes and Queries should be sent to Mr. George E. Davis, The Willows, Fallowfield, Manchester, before the 16th of each month.

As we wish to relieve ourselves of all purely business transactions in connection with the Journal, subscribers are kindly requested to pay the amount of their subscriptions to Messrs. Tubbs, Brook, and Chrystal, 11, Market Street, Manchester, to whom also all applications for advertisements should be made.

ALL MATTER intended for publication must be sent before the 12th of each month to the Editor, Mr. George E. Davis, The Willows, Fallowfield, Manchester.

DURING THE COMING YEAR we hope to be able to arrange for a series of articles "On the use of the Microscope in detecting the adulteration of food."

DR. HOLMES AND THE MICROSCOPE.—In a recent speech, Dr. Oliver Wendell Holmes,—the ever charming "Autocrat of the Breakfast Table," in illustrating the microscopic facilities of the Harvard Medical School, said: "A man five feet high, enlarged to correspond with the microscope power used, would be a mile high, would weigh 120,000,000,000 pounds, and could pick up the Boston State House and chuck it into the sea, cleaning out that ancient structure by a summary process which would put to shame the exploits of Commodus and his kind."

EDUCATIONAL SLIDES.—Mr. W. G. Rothwell has sent us some of his educational slides for examination, and we have no hesitation in saying that they are the best of the kind which have ever been brought under our notice. The section through the embryo of the grain of wheat is unusually good, while the thorn formation is well shown by sections of Raspberry, Dog-rose, Blackberry, &c.

COLE'S STUDIES.—Nos. 5 and 6 of the second volume of these "Studies" have been issued during the past month. No. 5 contains a coloured plate "Blood of Frog" double stained, the letterpress being devoted to a "Description," and the method of "Double staining amphibian blood." Volume II., No. 6, is really Section 2, No. 3, and in this, the cell theory is continued, with a coloured illustration of the siliceous valve of *Arachnoidiscus Ehrenbergii.*

On Nov. 18th, the fourth part of "The methods of Microscopical Research" was issued, containing a dissertation on "The preparation of Animal tissues."

ANIMAL HISTOLOGY.—Mr. Stanley, of London Bridge, has just issued for the use of students in Animal Histology, a set of twenty stained sections, in tubes ready for mounting and previous examination. These sections will be found a great boon by students, as they will be able to try the effect of reagents upon them before putting them up as permanent objects. A circular is issued with them, detailing the method of mounting and what to observe in the finished slides. The sections comprise the following:—Costal cartilage, Epiglottis, Bone, T. S., Bone, L. S., Finger of Fœtus, Ventricle of the Heart, Brain, Spinal Cord, Lung, Lung showing deposit of carbon from London smoke. Tongue, Kidney, Liver, Salivary gland, Thyroid gland, Scalp V. S., Scalp H. S., Skin of sole of foot, Testis, and Ovary.

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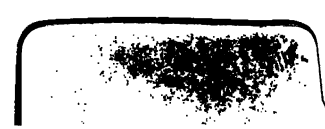
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